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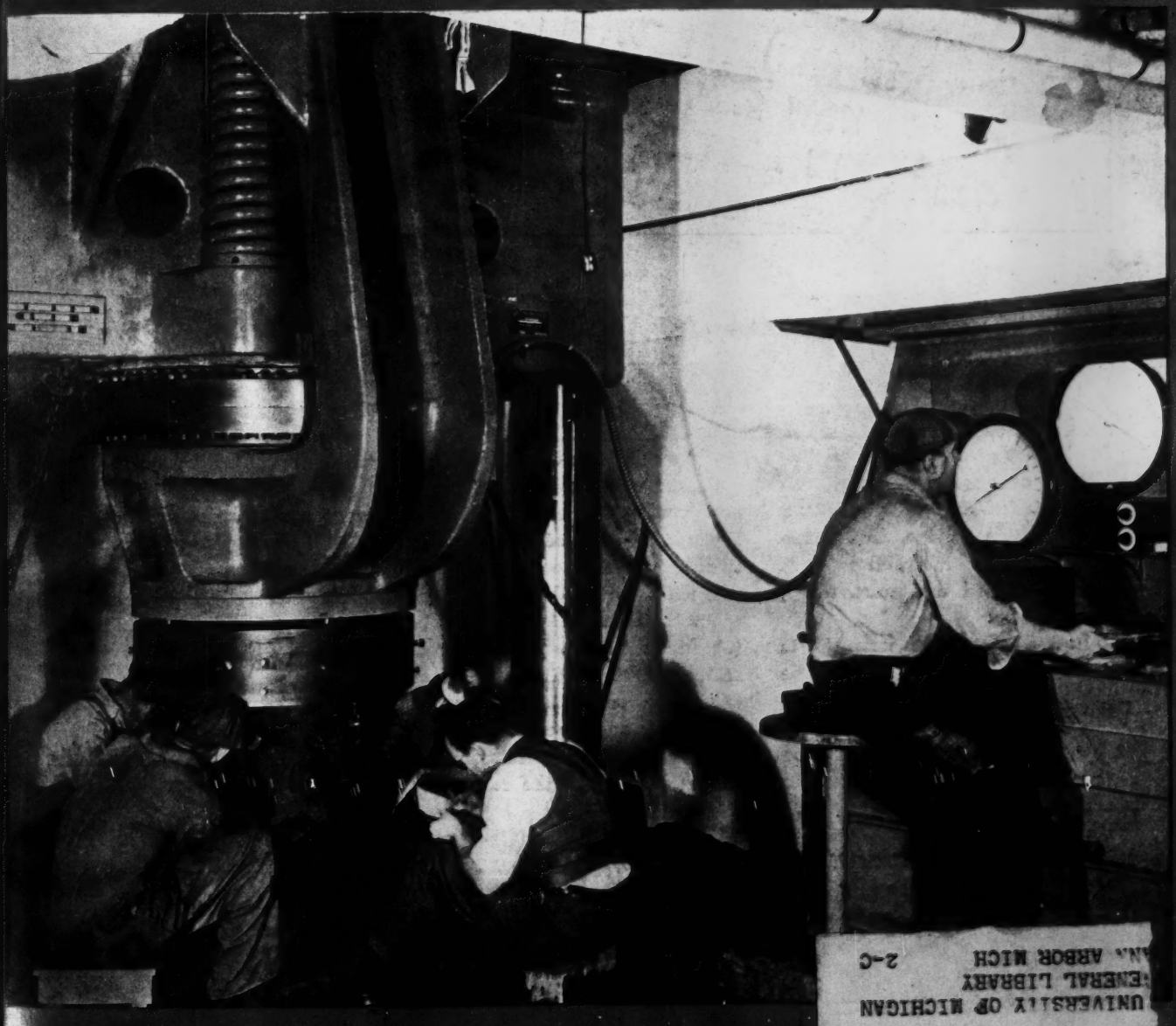
ME ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

MARCH 30, 1939

Research on a shelter unit in the Bureau of Reclamation lab at Denver—page 448



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Publication Office: 99-129 North Broadway, Albany, N. Y. • Editorial and Executive Offices: 330 West 42nd Street, New York

F. E. SCHMITT, *Editor* . H. W. CLARKE, *Publisher* . ALBERT E. PAXTON, *Manager*

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THIS WEEK

● A silver lining in one company's depression clouds. The Simonds Saw & Steel Co. had to stop construction on its windowless plant back in 1931 after walls and roof were complete. By waiting until 1938 to complete the building the Simonds people were able to take advantage of seven important years of development in the air-conditioning and lighting industries.

● Reports on highway subjects occupy a major position in this number. Beginning on page 53 are abstracts of papers from the San Francisco meeting of the American Road-builders Association. These are followed by Western Association of State Highway Officials meeting abstracts and a list of rules for designing concrete pavements as presented to the American Concrete Institute at its annual meeting in New York.

● Going the model-testers one better, Roy Carlson and Douglas McHenry, in cooperation with the TVA, are using Norris Dam itself as the subject for investigation of stress and strain conditions in such structures. Results indicate that refinements in construction procedure will improve gravity dams more than will changes in design practice.

THINGS TO COME

FOR NEARLY FIVE YEARS engineers and contractors have been engaged in building diversion works, supply canals, power plants and irrigation ditches for Nebraska's "Little TVA." This year construction was begun on an earth-fill dam second only to Fort Peck Dam in size which will store water for both irrigation and power. These projects have been visited by V. T. Boughton of the *ENR* staff. His observations on these controversial undertakings as a whole and on the details of work now in progress will be published in April.

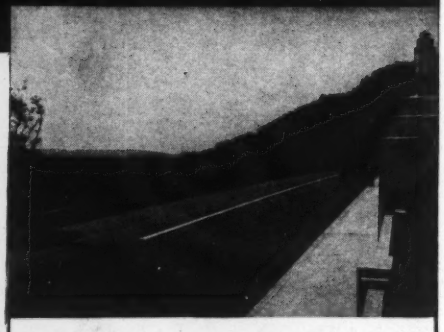
AS WAS MENTIONED on last week's "Men at Work" page, Des Moines' city engineer, J. M. Tippee, has had under his direction the design of a 20 m.g.d. WPA-built sewage disposal plant. In two weeks *ENR* readers will hear how the entire project was finished with relief labor.

12 INCHES THAT RULE THE WHOLE ROAD

THIS white concrete marker will continue to be a guide to traffic for years. It is made of white portland cement and white marble aggregate. That means long-lasting visibility and a greater degree of safety for every motorist who passes by.

Highway and safety officials know today that traffic markers made with Atlas White portland cement keep their bright whiteness. They do not mind neglect or dirty weather. Their dense, hard white surface never requires painting, repairing or replacing. They are as permanent as the pavement.

Here's a suggestion. Keep traffic running smoother—and safer; eliminate marker and curbing maintenance costs; reduce highway and street upkeep—all with Atlas White. Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.



● Twelve-inch concrete traffic marker, made with Atlas White portland cement and white marble aggregate. Laid on the Massachusetts Highway between South Deerfield and Sunderland. Contractor —C. J. Maney Company, Inc., Boston.

NR-M-1

ATLAS WHITE PORTLAND CEMENT FOR MARKERS AND CURBS

ENGINEERING NEWS-RECORD

NEWS

Volume 122 MARCH 30, 1939 Number 13

New York Starts City Housing

Project will be financed by proceeds from special city taxes on rented property

New York City made ready to start work last week on the country's first purely municipal public housing project when Mayor LaGuardia signed an amendment to the city administrative code permitting the plan to go into operation.

New York City's unique plan *(ENR,* June 30, 1938, p. 891) authorizes the New York City Housing Authority to issue bonds to be serviced from the proceeds of an occupancy tax levied last fall on rented business properties. It is now expected that the tax will provide funds to service a $10,000,000 housing program.

The city's first project, on which work may start within the next two months, will be a $2,000,000 development in Manhattan's lower East Side, housing about 270 f..milies. The project will be built immediately adjacent to a 1,500-unit federal project costing about $9,200,000. The two projects, in the Corlears Hook area, will be known as Vladeck Houses and Vladeck Federal Houses, respectively, after the late city councilman who was primarily responsible for development of the municipal plan.

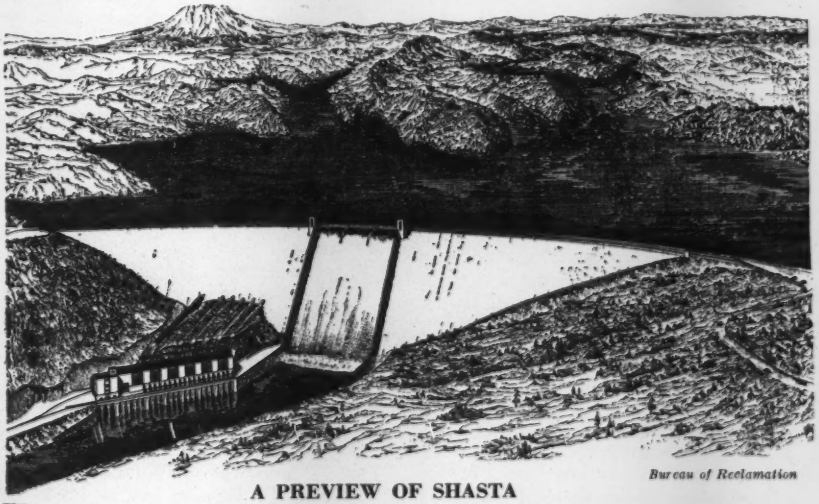
• • •

Contractors in Wyoming Must Pay Use Tax

Non-resident contractors operating in Wyoming must pay the state's 2 per cent use tax on equipment which they bring into the state for use on their contracts, State Attorney General Kerr ruled in an opinion last week.

The contractor is exempt from the use tax only if he bought his equipment before June 1, 1937, when the state use tax went into effect, or if it is to be used on a public works contract executed before Apr. 1, 1935.

The Wyoming use tax is imposed on all property purchased outside the state and brought into the state for use there. It is intended to prevent discrimination against Wyoming dealers who are subject to the state sales tax.



Bureau of Reclamation

A PREVIEW OF SHASTA

THIS OFFICIAL sketch of the Shasta Dam, which the U. S. Bureau of Reclamation is building on the Sacramento River as part of the Central Valley project in California, shows how the dam will look when finished. Of gravity type, Shasta will be larger than Boulder Dam, and its spillway, 490 ft. to the top, will be the highest in the world.

Airport Preference In Relief Funds Urged

Aeronautics Authority informs Congress that airport construction merits federal aid

The Civil Aeronautics Authority reported to Congress last week that $125,000,000 could properly be spent during the next year on improvement of airports. The report urged that as long as federal money is being granted to local agencies for public works, a preferential proportion of such money be allocated to airport purposes.

Improvements to bring to "a properly high standard of quality" all airports now designated as air mail stops would require the expenditure of $128,000,000, the report pointed out. There are now 236 airports designated as air mail stops, but only 179 actually receive service. An expenditure of $230,000,000 would permit adequate development of 860 airports, while expenditure of $435,000,000 would place an airport within 30 minutes drive of every reasonably compact population of 5,000 persons or more. This would involve provision of 3,500 adequate airports.

Over the past six years, $140,000,000 of federal funds has been expended on airports through WPA and PWA.

CAA urges that whenever the present public works and relief program is

(Continued on p. 40)

• • •

Georgia to Vote On Four-Lane Road

A proposal to rebuild the 140-mile Atlantic Coastal Highway across southeastern Georgia as a four-lane road will be set before Georgia voters in the next general election. If the proposal carries, it will be necessary to hold a second election in the six-county highway district involved on a $4,500,000 bond issue to supplement federal funds in rebuilding the road. At this election it will be necessary for the proposal to pass in Chatham County, since that county would pay 70 per cent of the interest on the bonds.

Government Pay Held Taxable

U. S. Supreme Court says states and nation may tax each others employees

The long-standing doctrine that federal and state governments may not impose income taxes upon each other's employees was completely upset by two U. S. Supreme Court decisions handed down March 27 in cases concerning state income taxes imposed upon an HOLC employee by New York and an RFC employee by Utah.

By a 6-2 division the court held that "the only possible basis for implying a constitutional immunity . . . is that the economic burden of the tax is in some way passed on so as to impose a burden on the national government tantamount to an interference by one government with the other . . ."

This, the court held, is not the case in regard to a non-discriminatory tax such as a state income tax. "In this respect we perceive no basis for a difference in result whether the taxed income be salary or some other form of compensation, or whether the taxpayer be an employee or an officer of either a state or the national government, or of its instrumentalities. In no case is there basis for the assumption that any such tangible or certain economic burden is imposed on the government concerned as would justify a court's declaring that the taxpayer is clothed with the implied constitutional tax immunity of the government by which he is employed."

Previous cases to the contrary are specifically overruled "so far as they recognize an implied constitutional immunity from income taxation of the salaries of the officers or employees of the national or a state government or their instrumentalities."

• • •

Safety Agency Set Up For Federal Employees

In an effort to reduce the frequency of accidents among federal employees, the President has established the Federal Interdepartmental Safety Council "as an official advisory agency in matters relating to safety of federal employees." Made up of executives in the federal service whose work involves responsibility for safety and health of employees, the council will act as a clearing house for accident and health information and will conduct surveys and other investigations.

The council was set up after a preliminary survey, begun in 1935, had indicated that the accident experience among various federal agencies is higher than comparative experience in private industries, resulting in a direct annual cost to the federal government, under the U. S. Employees Compensation Act, of about $10,000,000. A reduction of at least 40 per cent in deaths and injuries to government employees by 1942 has been suggested to the council as a goal by Secretary of Labor Perkins.

• • •

Spring Flood Destroys Colorado Dams

Three dams, a diversion canal, and a section of highway were damaged Mar. 23 when unprecedented spring floods rampaged down Box Elder Creek toward the South Platte River, 25 miles northwest of Denver.

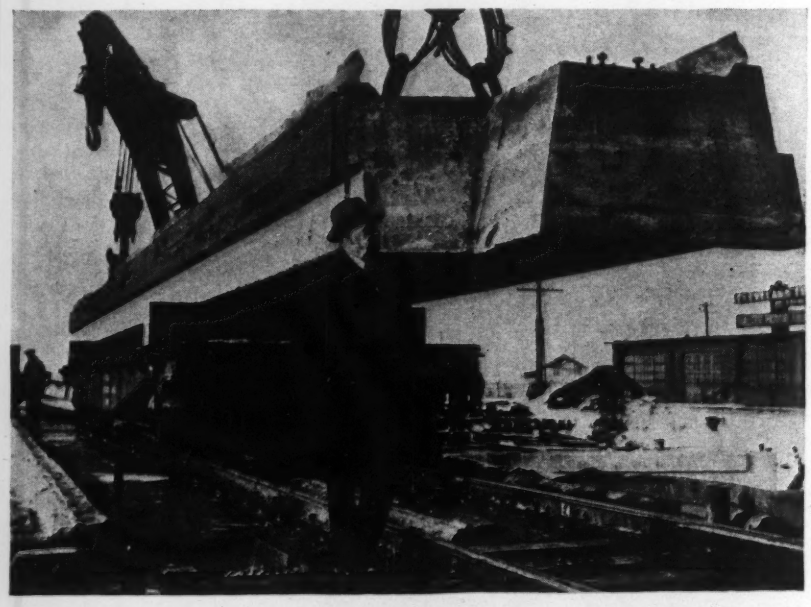
The flood, caused by unseasonable high temperatures in the mountains above Box Elder Creek, first damaged a diversion canal below Bootleg Reservoir, then overtopped Moonshine Dam, an earth-fill structure built in 1925. A 250 x 20-ft. section went out, releasing 1,200 acre-ft. of water which helped take out two other dams with a combined capacity of 600 acre-ft. A 3,000 ft. section of state highway east of Hudson, Col., was washed away, a 300 ft. length being scoured to a depth of 20 ft.

Federal Government May Take Hetch-Hetchy

Possibility that the federal government may take over the marketing of power generated from San Francisco's Hetch-Hetchy water supply development was indicated March 23 by Secretary of the Interior Ickes.

The power development, based upon federal permission to use lands of Yosemite National Park, was licensed with the provision that none of the output be sold to individuals or corporations (except municipalities) for re-sale to the public. The city, however, turned it over to the Pacific Gas & Electric Co. as its "agent" in distributing the power to the ultimate consumer. This, the Secretary ruled, was a violation of the grant. The city took the ruling to court and lost the case, the court holding that the city must cancel its contract with Pacific Gas & Electric. The city has taken the case to the higher courts on appeal.

"If the court upholds our contention that San Francisco is violating the law," said Ickes, ". . . there should be some forfeiture of the power to the federal government . . . In a very general way, we have discussed possible other outlets for the power. I think that we may have a lot of it on our hands for disposal."



Canadian National Railway photo

A PRECAST BRIDGE IN CANADA

TWO CRANES were required to swing this 130-ton precast concrete bridge slab into its place on the 18th St. grade separation project in Toronto. Ten of these slabs, each 80 ft. long, 3 ft. deep and 6½ ft. wide, were used in building the recently completed five-track bridge to carry the main line of the Canadian National Ry. Rails are attached to "chairs" held directly to the concrete.

Charles P. Disney, bridge engineer for the CNR, who designed these precast sections, is shown inspecting one of them. An article on CNR precast bridge practice appeared in *ENR* July 19, 1934, page 65.

LABOR NOTES

AN EMPLOYEE of a Massachusetts firm, injured while temporarily in California on business, is entitled to compensation under California law regardless of provisions of the Massachusetts compensation law, the U. S. Supreme Court held Mar. 27.

A GENERAL STRIKE of iron workers on all PWA projects in the Chicago area was called Mar. 24 by the Chicago local of the Bridge and Structural Iron Workers Union. The local is seeking to compel employment of its men to handle reinforcing steel, steel forms, and all structural steel used in the new Chicago subway project. This work is being handled at present by members of the Tunnel Workers Union. Both unions are AFL.

TUNNEL WORKERS on the Green Mountain Tunnel unit of the Big Thomson-Grand Lake project in Colorado returned to work Mar. 21 after a six-day strike. The strike, called by the International Union of Mine, Mill and Smelter Workers, CIO, was terminated pending investigation of the workers' complaints by the Colorado Industrial Commission.

• • •

Indiana Planning Board Faces Suspension

Activities of the Indiana State Planning Board are expected to halt as a result of state legislation cutting its appropriation from $20,000 to $3,500. Planning board director L. F. Moorman states that "obviously the $3,500 is hardly enough to pay rent and heat for an office."

Recently the board has been carrying on a study of the state's water resources and compiling data on drainage basins and flood control work. It has aided in the establishment of thirteen local planning commissions in Indiana.

Bureau of Reclamation Photo

IT WILL PROBABLY GO HIGHER

MARSHALL FORD low dam, which the Bureau of Reclamation is building on the Colorado River for the Lower Colorado River Authority, is now approaching completion, but the authority has announced that it hopes to proceed at once with construction of the high dam, 78 ft. higher. (*ENR*, Mar. 23, 1939, p. 1)

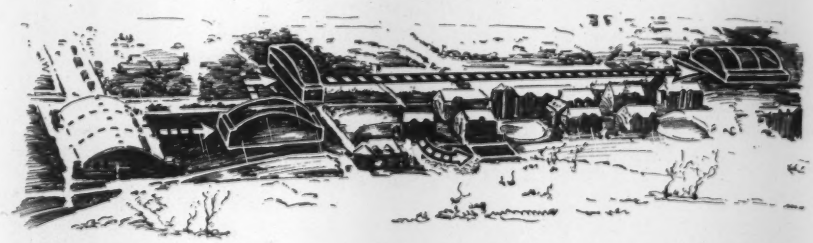
The downstream face of the dam, shown above, will be unchanged by the addition of the high dam. Plans for the additional construction call for extending the dam upstream.

Brown and Root and the McKenzie Construction Co. hold the $5,781,000 contract for the present low dam.

Misunderstanding Causes Retaining Wall Break

Confusion as to who was responsible for the sluice gates of the Emrichsville dam on the White River, part of the Indianapolis riverside flood prevention project, resulted in the carrying away of a 40-ft. section of the retaining wall below the dam, when the sluice gates were left open during high water Mar. 20. The city engineer was unaware that the flood control board had the keys to the sluice gates.

HOW A 130 x 300-FT. GYMNASIUM WILL BE MOVED



AS PART of the building program for the new Institute of Technology at Northwestern University, it will be necessary to move the Patten Gymnasium. The big building will be cut into three parts, as shown, and moved part by part, being rotated 90 degrees in the process.

New Technical School At Northwestern

Institute on cooperative plan made possible by $7,000,000 gift from Walter P. Murphy

An Institute of Technology operating on a cooperative plan with students alternating 12-week periods at the school and similar periods working in Middlewestern industries is to be established at Northwestern University with the aid of a $6,735,000 gift from Walter P. Murphy, president of the Standard Railway Equipment Co. Herman Schneider, dean of engineering at the University of Cincinnati, was adviser to Murphy in working out the cooperative plan, which is to be undertaken experimentally for a five year period. O. W. Eshbach, personnel director of the American Telephone & Telegraph Co., has been offered the deanship of the new institute.

The institute will accept 800 students and will be housed in a single four-story building 500x250 ft. on the Evanston, Ill. campus. Half of the building will house the chemistry and physics department and research laboratories and the other half the departments of civil, mechanical, electrical, and chemical engineering. Construction will start in a few months, and the building is scheduled to be ready late in 1940.

Construction of the institute building will require removal of the Patten Gymnasium and a number of other buildings. The gymnasium, a brick and limestone structure 130x300 ft. in plan with an arched roof 50 ft. high, will be cut into three pieces. Each piece in turn will be jacked onto a special framework intended to keep the walls from buckling. The frames will then be moved along I-beam tracks across a road, turned 90 degrees so that the west entrance faces north, and then moved to the final location.

• • •

Truck Weight Limit Raised in Tennessee

The limit on the weight of trucks and tractor-trailer combinations operating over Tennessee highways is increased from 18,000 lb. to 24,000 lb. Apr. 1 under the terms of a new law. Axle loading is limited to 16,000 lb. The department of safety may grant special permits for occasional movement of vehicles weighing more than 24,000 lb. and may also reduce the permitted maximum weight on secondary roads.

The new law also substitutes a registration fee based on maximum gross weight for the former mileage tax.

Connecticut Civil Engineers Review Hurricane Experience

State Society of Civil Engineers holds annual convention at New Haven with interest centered on storm damage

One of the largest and oldest of the state engineering societies held its annual meeting, March 21 and 22, at Yale University in New Haven, Conn. It was the fifty-fifth convention of the Connecticut Society of Civil Engineers, and about 100 of the 900 members attended to listen to papers on a wide range of subjects, with particular emphasis on engineering aspects of the September hurricane. Charles Rufus Harte was elected president to succeed Elwood T. Nettleton.

Papers on the September hurricane and flood were the outstanding events of the convention. One on shore damage and protection by Lieut.-Col. C. H. Cunningham, assistant division engineer in the North Atlantic Division of the Corps of Engineers was characterized by C. E. Smith, vice president of the New Haven Railroad, one of the discussors, as the "most valuable contribution in engineering literature relating to the coast line of Connecticut." In his paper Colonel Cunningham reviewed and analyzed the shore-forming processes of wave action and currents. The compartmented nature of the Connecticut shore line was emphasized as aiding in protection against erosion but resisting attempts of waves and littoral drift to build sandy beaches.

In discussing shore-protective works, Col. Cunningham pointed out that efficient use of bulkheads and groins is dependent upon the existence of littoral drift; otherwise a seawall is called for. Furthermore, the presence of sufficient sand is essential to proper beach building in the presence of littoral drift. Groins act to conserve the sand at the beach and may be rated as successful if they reduce the loss to such an amount that local interests can afford to replace the sand periodically. Offshore breakwaters may also be useful in reducing the strength of wave attack.

Col. Cunningham suggested that the state or separate towns might acquire low sand strips and baymouth bar areas not suitable for summer residences and convert them into parks. In so far as the federal government is concerned, present legislation limits its aid to surveys and recommended plans by the Beach Erosion Board, the sponsoring local agency paying one-half of the cost.

Another hurricane paper related to the floods in the rivers and was presented by Burke L. Bigwood, district engineer at Hartford for the U. S. Geological Survey. Records indicate that, except in the extreme eastern part of the state, the five-day rainfall was nowhere less than 8 in. At some stations 24-hr. rainfall of as much as 6 or 7 in. was observed, with a rate of fall at times of more than 1 in. per hr. Heaviest rainfall generally occurred in the eastern half of the state. The surprising feature of the 1938 flood is that it developed at a season of the year when the maximum amount of precipitation was required to produce a given flood. The rainfall statistics indicate that, in a distance of only 35 miles, precipitation ranged from less than 4 in. at New London to 17 in. at Middletown over the 5-day period.

Record rainfall

Curves constructed to show the weighted average depth of rainfall over a given area place the 1938 figures far above any other storm—for example, 16 in. over an area of 250 sq. mi.; 15 in. over 650 sq. mi.; 14 in. on 1,800 sq. mi.; 13 in. on 3,500 sq. mi., and 12 in. over 6,600 sq. mi., the latter figure exceeding the area of the state.

Such a storm produced record-breaking runoffs. Determinations completed to date give results for Connecticut streams as high as 130 sec.-ft. per sq. mile from 400 sq. miles; 190 sec.-ft. from 170 sq. miles; 195 sec.-ft. from 11 sq. miles; and 388 sec.-ft. from 1.6 sq. miles. For all sizes of drainage area the 1938 storm produced twice the discharge of the 1936 storm.

In discussing Mr. Bigwood's paper, H. B. Kinnison of the Boston office of the U. S. Geological Survey, which operates 95 gaging stations in Massachusetts, Vermont, and New Hampshire, stated that a proper distinction between the 1936 and 1938 floods would be that in 1936 the stages of the tributary streams were of long duration—two or three days—so that they overlapped in the main streams and gave the latter their record breaking stages. In 1938 the stages in the tributaries were high and short so that the discharges went down the larger rivers one at a time and did not pile up. Mr. Kinnison reported a discharge for the West River in Massachusetts, with a 300-sq. mi. drainage area, of 175 sec.-ft. per square mile as compared to 127 in 1936. He also listed the discharge of the Deerfield River at Charlemont, on a 178-sq. mile drainage area, as 316 sec.-ft. per sq. mile, a figure which is believed to be correct on the basis of discharges measured on some of the Deerfield tributaries which ran up as high as 700 sec.-ft. per sq. mile on a drainage area of 25 sq. miles.

Completing the part of the program devoted to the hurricane were papers by C. J. Daly, Southern New England Telephone Co., and Cecil W. Brown, Connecticut Power Co. Falling trees caused the principal damage to phone and power lines. Despite power line failures, telephone storage batteries were not out of service, although rented welding machines were used to charge them at 29 of the 79 central offices; these were so successful that a file of owners is to be kept against future emergencies. One of the principal lessons learned is to locate important lines in rights-of-way free of trees; another is to avoid bridges to carry lines across streams, long-span aerial construction being recommended instead. The main power stations, rebuilt after 1936, proved essentially floodproof in 1938. The money loss to power companies, although extensive, was not sufficient to warrant underground construction of lines, according to Mr. Brown, who suggested that essential facilities such as hospitals, water purification plants, etc., supply themselves with emergency generating sets as insurance against power failures.

City engineering and planning

In a paper on municipal engineering, Robert J. Ross, city engineer of Hartford, described the efficient organization that non-political control has made possible in his city. In the first place, by state legislative act, the city engineer holds office during good behavior and has complete hiring and dismissal authority over his staff. In Hartford, the staff combines specialists in every branch of engineering. Each department head has an understudy. Positions are always filled from within the department. Continuity of the force makes it possible to study long range problems and work out tentative solutions that prove useful when the job is finally authorized. Mr. Ross' philosophy may be summed up as follows: "A municipal engineering department should be considered as a perpetual institution, free from political control and directed by a city engineer and a qualified staff who regard their position as one of public trust, which is indispensable to the taxpayer."

W. Vincent Barry, city engineer of New Haven, in discussing the paper, strongly supported a charter setup that gives the city engineer a clear right

to control his personnel. This arrangement is much to be preferred, in his opinion, to civil service.

In a paper on town planning in Connecticut, F. Perry Close, planning consultant, West Hartford, urged combination planning and zoning boards to the end that plans and practice may be coordinated. Only 40 of the 142 towns in Connecticut have adopted any form of government planning or zoning, and most of these are adjacent to urban centers. Mr. Close pointed out that more remote towns are experiencing a growing need for zoning as a result of the change from agriculture and industrial to resort and suburban character. In discussion Prof. Charles S. Farnham, Yale University, pointed out the need for zoning river valleys to prohibit building in hazardous locations. Another discussor instanced an original and effective method for such zoning wherein only the most expensive residences are allowed in a low flood plain; this keeps out the dwellers of low income class, and the high cost residence naturally will not be built in such a location.

Building maintenance

Yale University's many buildings present a maintenance problem of first magnitude and William W. Randolph, in charge of this work, expressed the creed that the easiest and least expensive remedy for maintenance troubles is to correct them when they are small. Periodic and detailed inspections are the rule, so that this policy can be adhered to. Practices and costs as outlined in this paper will be published in a future issue.

Highways and surveying

Connecticut has a bridge repair and replacement problem that is no easier nor more difficult than that of other states, said Leslie G. Sumner, state bridge engineer. About 100 of the 2,300 state highway structures are listed for replacement because of major defects at the present time, and it is probable that 300 more grossly inadequate bridges exist on local roads. It is estimated that a $4,500,000 program would be necessary for the 100 state highway bridges and an additional $4,500,000 would be required for the 300 local road bridges. Connecticut needs an inventory of its bridges, a logical program of replacement, and more uniformity in design practice among the various bridge building agencies, said Mr. Sumner.

The state highway planning survey in Connecticut was described by Warren M. Creamer, state manager of the work. Connecticut is the forty-sixth state to start this survey, which was laid out by the U. S. Bureau of Public Roads to give a nationwide picture of road facilities and needs.

Another federal aid operation of great use to Connecticut—the laying out of the plane coordinate net of control surveys—was described by Henry D. Crute, project supervisor. Arcs have been completed along the Northern and Rhode Island boundary, north and south along the Connecticut River, and east and west across the center of the state. Thus points fixed by latitude and longitude are available to a large area of the state and to most of the large cities. Some of these points are preliminary, but final coordinates have been issued for five of the 24 geographical quadrangles of the state, covering about 1,000 control points.

ENR Staff Photo

DAM WITHOUT WATER

NOT BUILT to store water, the North Fork debris dam completed this month near Auburn, Calif., will provide a 20-year storage for mining debris in its 25,000,000-cu.yd. reservoir. Under California law, mining debris cannot now be dumped back into the river channel as it was in the early days.

The dam is an arch concrete structure 155 ft. long and 620 ft. long. Built under supervision of the U. S. Engineer Department, it contains 29,500 cu.yd. of concrete, is 22 ft. thick at the base and 6.8 ft. thick at the crest.

• • •

New Licensing Law Passed in Idaho

A bill providing for the licensing of Idaho engineers in all branches except mining has been passed by the state legislature and signed by Governor Bottolfsen. Conforming closely to the model law, the bill sets up an independent examining board, with the cost of administration paid from license fees.

Study Successor To Bonneville Head

Washington Correspondence

Administration officials are canvassing the field for a possible successor to the late J. D. Ross, Bonneville power administrator. The selection will not be an easy one. Qualifications of the ideal candidate would include, first of all, unmistakable identification with the public power movement; second, sufficient knowledge of the utility business to ensure efficiency in administration. Although not necessarily an engineer (for the technical development of the Bonneville project is now well advanced) this man should be an effective salesman, at the same time possessing the tact to get Bonneville power sold with the minimum of irritation to the private utilities.

Of course such a man does not exist, as the Administration is prepared to admit, and in selecting a new administrator it will be necessary to accept the nearest possible equivalent. To complicate the problem, the appointment will be for an indefinite term, and the incumbent will face the possibility of being turned out of office should there be a change of administration in 1941. To a really first-class man the combination of hard work, moderate pay, and uncertain tenure has its drawbacks.

There is no possibility, of course, of a selection being made from the private utility industry, the obvious training ground for a power administrator. Nor is there any outstanding possibility among the personnel of the municipal plants of the country, most of which are of comparatively small size and limited service areas. Several persons now in the government service are possibilities, including ex-Senator James P. Pope and David E. Lilienthal of TVA, Clark Foremen, head of PWA's power division, John M. Carmody of REA, and Frank P. Walsh, now with the New York State Power Authority. It is doubtful if any of these are active candidates, but one of them might possibly be "drafted" by the President should no one else be found.

In the Pacific Northwest there are, of course, a host of willing possibilities, but it is generally thought that the Administration will, if possible, avoid appointing a local man. Controversies regarding Bonneville power are still fresh in the memory of the federal authorities and it is felt that the best way to avoid entanglements is to bring someone in from outside. J. D. Ross, it is pointed out, was appointed in spite of, not because of, his prior connection with the Pacific Northwest.

OBITUARY

REAR ADMIRAL RALPH M. WARFIELD, 58, public works officer of the Third Naval District, died last week in New York City. A graduate of Worcester Polytechnic Institute, Admiral Warfield had been in the Navy Civil Engineer Corps since 1907. He had been public works officer in the fifth district as well as the thirteenth district. Before joining the Navy he was for some years a structural draftsman and taught civil engineering at the University of Vermont.

WILLIAM LANSING, who retired in 1937 from an engineering post on the staff of the city of New York, died there Mar. 20 at the age of 65. A graduate of Yale in 1893, Lansing was for ten years an engineer for the Southern Pacific Ry. He served in France as a captain in the Engineer Corps and while in the employ of New York City was engineer in charge of construction of Staten Island docks and the Floyd Bennett airport.

GEORGE L. COOLEY, 78, Ohio road contractor since 1900, died Mar. 16 in Dover Center, Ohio. Between 1905 and 1910, Cooley helped organize the state highway departments of Ohio, Louisiana and California and he was for some years state highway commissioner of Louisiana. He was a graduate of Ohio Northern University.

HOMER ELKINS, 32, an engineer for the Oklahoma state highway department, was killed Mar. 18 in an automobile accident.

DILWORTH M. TAYLOR, for 38 years a civil engineer for the Wheeling & Lake Erie R.R. at Cleveland, died there Mar. 13. Taylor was a graduate of Pennsylvania State University.

BAILEY H. NEWLEE, 63, a civil engineer for 43 years with the Atchison, Topeka & Santa Fe R.R., was killed Mar. 3 when he fell from a building under construction in Chicago.

FRANK R. PATTERSON, president of the Patterson Engineering Co., a Detroit contracting firm, died in Detroit Mar. 22 at the age of 46.

A. J. HANCOCK, project engineer for the Florida state road department, died at Jasper, Fla. early this month.

WILLIAM A. TAYLOR, Pasadena, Cal. contractor who built the Pasadena Rose Bowl, died there Mar. 25.

E. HENRY PORTER, a retired civil engineer, died in Bartlett, Tenn. Mar. 20 at the age of 80.

CHARLES W. FERREN, Des Moines contractor, died in Ames, Iowa, Mar. 22 at the age of 49.

OWEN F. BRINTON, principal mining engineer for the U. S. Engineer Corps at Fort Peck Dam in Montana, died in Denison, Tex., Mar. 15, aged 55. Brinton graduated from the Montana State School of Mines in 1905 and worked for some years for the Anaconda Copper Mining Co. In 1914 he went to India as superintendent of construction on the Tiger Tunnel, and on returning two years later became manager of the Admiralty Zinc Co. He served during the war as a captain of engineers and afterward worked on mine and tunnel projects in Utah and Montana until 1928, when he went into business as a consultant. He was engaged by the Army Engineers for the work at Fort Peck in 1933. On that project he had charge of tunnel operations and was chief of operations for construction of the diversion tunnels. Upon completion of these tunnels in 1937, Brinton became general superintendent for the contractors on the spillway gate structure, and at the time of his death he was chief of operations at the government-operated Snake Butte quarry.

• •

Chicago Manhole Explosion Kills City Employee

A Chicago water department employee was killed Mar. 23 by exploding gas in a manhole in South Kedzie Ave. During repair work on a water main, the water had been shut off and the main sterilized with chlorine gas. The man went into the manhole to open a valve to restore the flow of water when the explosion occurred. The accident is being investigated by the purification division for the water department.

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Airport Preference In Relief Funds Urged

(*Continued from p. 35*)

terminated airport development be continued by annual federal appropriations limited to projects of exceptional national interest.

At present, it is recommended that local sponsorship of airport relief projects be assumed by the states. Airport buildings should be eligible for extra federal aid only when they are essential to safe and efficient use of an otherwise qualified air field. CAA advises against federal contribution to the cost of maintaining airports except for the operation of airport lighting equipment and navigation aids.

Flood District Tax Upheld by Supreme Court

The U. S. Supreme Court on Mar. 27 upheld the right of the Los Angeles County Flood Control District to levy assessments on all land in the district to meet the cost of drainage work inside the district. The case arose when the California legislature in 1937 authorized the flood control district to take over certain drainage districts within the flood district's territory, assume their bonded indebtedness, and levy assessments on all landowners.

The plaintiff in the present case owned land in the flood control district but not in any of the drainage districts, and he contended that he did not have to pay assessments without having a chance to a hearing on whether his land will be benefited by the drainage work.

Affirming a state supreme court decision, the U. S. Supreme Court held that the legislative authorization of the flood control district act constituted a conclusive finding that all lands in the district would be benefited by the drainage work.

"Where the legislature itself," the court said, "has found that the land included in the district will be especially benefited by the improvement, prior adequate inquiry is presumed, and the finding is conclusive . . . but where the district was not directly created by the legislature and there has been no determination by it . . . the owners are entitled . . . to be heard by some officer or tribunal empowered . . . to hear them and to consider whether their lands will be especially benefited . . ."

• • •

Irrigation District Sued For Engineering Fees

Black & Veatch, Kansas City consulting engineers, have filed suit in the federal court at Grand Island, Neb., to collect $69,138 from the North Loup River Public Power and Irrigation District for fees claimed to be due them under their contract with the district for engineering work in connection with the design and construction of the district's irrigation project. The district officers hold that a check for $3,500 sent after the suit had been filed completed the district's payment under its contract with Black & Veatch.

It is understood that the Black & Veatch claim for payments in excess of the amount held by the district to be its full obligation is based on a clause in their contract which permits them to charge additional fees for the supervision of contractor's work not completed on the date specified in the contract.

Health Service Starts Sewage Plant Census

A continuing census of water purification and sewage treatment works throughout the United States has been inaugurated by the U. S. Public Health Service. The census work will be done at the service's stream pollution investigation station at Cincinnati.

The program, according to a statement to *Engineering News-Record* by J. K. Hoskins, senior sanitary engineer for the service, will include collection of information, in cooperation with state and municipal agencies, on the physical, structural and operating features of individual plants as well as on the location and nature of water pollution problems. The data obtained will be available at all times to those interested, and summaries will be published periodically.

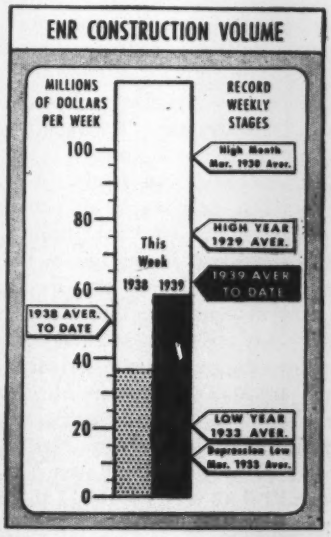
CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $59,044,000, are 59 per cent higher than in the corresponding 1938 week, and 2 per cent above last week.

The current week's total brings construction awards for 1939 to date to $801,102,000, an increase of 22.4 per cent over the volume for the initial 13-week period last year.

Private construction for the week tops a year ago by 28 per cent, but is 37 per cent under a week ago. Public awards are 73 per cent and 29 per cent higher, respectively, than last year and last week.

The $10,680,000 award for the Delaware Aqueduct water supply tunnel in New York brings waterworks to its third highest week of the year; and a $5,000,000 program of gas and electric system improvements in the Albany, New York, area brings unclassified construction to its second highest weekly level of 1939. In addition to waterworks and unclassified construction, sewerage, bridges, industrial and public buildings top the corresponding week in 1938, and bridges, commercial building and large-scale housing, and streets and roads are above last week.



New capital for construction purposes for the week totals $9,917,000, 55 per cent below the volume for the 1938 week. The current week's total is made up of $5,573,000 in REA loans, $4,104,000 in state and municipal bonds, and $240,000 in corporate security issues.

New construction financing for the 13 weeks of 1939 to date, $505,991,000, is 36 per cent higher than the volume for the first quarter last year.

CONTRACTS

(Thousands of dollars)

	Week Ending Mar. 31 1938	Mar. 23 1939	Mar. 30 1939
Federal	$2,822	$3,865	$3,850
State & Municipal	22,524	30,262	40,117
Total public	$25,346	$34,127	$43,967
Total private	11,763	23,766	15,077
TOTALS	$37,109	$57,893	$59,044
Cumulative 1939 (13 weeks)			$801,102
1938 (13 weeks)			$654,685

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 13 Wk.	1939 13 Wk.
NON-FEDERAL	$371,053	$232,491
Corporate securities	93,275	42,132
State & Mun. bonds	201,019	143,623
R.E.A. loans	.....	21,204
R.F.C. loans	62,420	58
P.W.A. allotments	—2,497	.....
U.S.H.A. loans	15,836	25,474
FEDERAL	.....	$273,500
TOTAL CAPITAL	$371,053	$505,991

FHA MORTGAGES

	Week Ending Mar. 26 1938	Mar. 18 1939	Mar. 25 1939
Selected for appraisal	$22,568	$25,901	$26,600*
Cumulative 1939 (12 weeks)			$255,852*
1938 (13 weeks)			$155,655

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Mar.	234.43	112.69
Building Cost	Mar.	196.46	106.20
Volume	Feb.	187	82

N. Y. Works Head Dies at 68

Frederick Stuart Greene had held important engineering posts with state since 1919

Only a few days after his announced retirement as superintendent of public works of New York State, Frederick Stuart Greene died in Washington at the age of 68 on Mar. 26. During his career with the state, Greene was said to have awarded and supervised more public improvement contracts than any similar official in America, state contracts executed during his tenure of office having amounted to nearly $1,500,000,000.

Greene graduated from Virginia Military Institute in 1890 and two years later joined the staff of the War Department on river and harbor improvements in New York State. From 1896 to 1899 he worked for John Monks & Sons, New York City contractors, on waterfront and foundation construction. He then spent five years in charge of the transmission rope department of the American Manufacturing Co. and afterwards joined the executive staff of The Waterproofing Co., New York City roofing contractors.

At the outbreak of the war, Greene entered the first officers training camp and went overseas as commander of Company C of the 302nd Engineers, rising to the rank of acting major. Immediately upon his return to this country in 1919 he was appointed superintendent of highways of New York State by then Governor Smith and, except for a brief interval from 1921 to 1923 during which he went into business as a highway contractor, he had been in the state service ever since. When the state government was reorganized in 1925, Greene was appointed superintendent of public works and made a member of the cabinet.

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Montana Dam Break Being Investigated

The Montana State Water Conservation Board has begun investigation of the collapse earlier this month of an earth-fill dam across Big Dry Creek at Jordan (*ENR*, Mar. 23, 1939, p. 1). In a statement to *Engineering News-Record*, state engineer Donohue said that the break was due to a pocket of porous soil in the foundations.

The dam was 3,655 ft. long and 46 ft. high; a 70-ft. wide breach was made in the dam. The statement, in last week's issue, that the dam was only 15 ft. high was incorrect.

Further news on page 80

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Public Relations

Sir: The article, "Selling Good Will with Good Water" (*ENR*, Mar. 16, 1939, p. 56) by J. O. Herr, manager of one of our subsidiary companies, was of special interest to me. Our company believes that each member of the staff should always endeavor to improve the public relations of the operating company for which he works. Our management believes that a public relations program cannot be alone the concern of a highly functionalized department; rather we try and interest everyone in the important job of making friends with our customers and maintaining this friendship once made.

We feel that sound public relations are based on harmonious employee relations, and that customer friendship grows on the firm foundation of a satisfied and cooperative employee group. Of course, we know that there can be no sincere attempt to promote and maintain good public relations unless service is good and dispensed at fair rates.

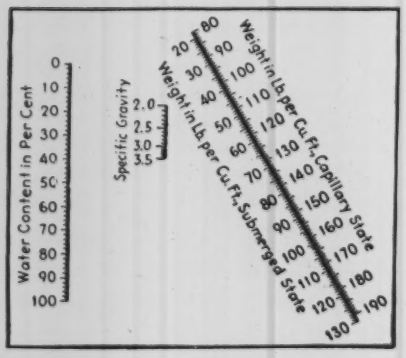
P. B. NILES
Director of Information
American Water Works and Electric Co.
New York City

Inaccurate Nomograph

Sir: I am lately in receipt of a communication relating to a soil weight chart I submitted to you last summer which you were kind enough to publish (*ENR*, Aug. 18, 1938, p. 215). My correspondent calls my attention to the fact that the cut does not give correct values of the soil weights. Being out of the city on the date of publication, I was unable to check the copy and the matter subsequently slipped my mind. But it is apparent that your draftsman failed to preserve the proper proportions in the cut. Inasmuch as a chart of this type is based on strict mathematical laws the result of any distortion will be obvious.

WALTER E. COWAN
Consulting Civil Engineer
Oak Park, Ill.

The correct drawing is published herewith.—EDITOR



Water for the Great Plains

Sir: Though I am a reader of *Engineering News Record*, I did not note your editorial comment "Not Through Irrigation," on p. 607, Nov. 17, until called to my attention. I believe a few additional facts regarding the subject of this editorial as it applies to North Dakota will be of interest to the engineers in general.

Those engaged in the engineering profession desire to see some tangible benefits as a result of the expenditure of public funds. Such benefits are not apparent from the following statistics: The federal government made available to the people in North Dakota $109,808,905 in grants; $163,421,701 in loans, and $88,510,609 for work relief between March 1933 and July 1, 1938. Additional sums since July 1 have brought the total over $400,000,000.

During the same period, valuation of all property decreased from $1,038,268,187 to $943,826,989, a decrease of approximately 9 per cent. The average tax delinquency increased from 16 per cent to 54 per cent. Population decreased approximately 8 per cent, and the number requiring public assistance may reach a maximum during the current winter.

The money spent for work relief was probably used in the construction of as meritorious a group of projects as government restrictions permitted. However, these projects do not provide permanent rehabilitation for the distressed people as is quite evident from the above data.

Seven years of drought, as stated in the above mentioned editorial, is not entirely responsible for this situation. Precipitation for the state, as a whole, according to government records, was normal or above during the following years 1932, 1935, 1937, and during the growing season of 1938. Some of the present difficulty is due to the fact that such large numbers of livestock had to be shipped out of the state during 1934 and 1936, due to lack of winter feed, that many farmers and ranchers are deprived of an income from this source at the present time. It will take years for them to provide themselves with the fine herds that had to be sacrificed on a depressed market.

Mention is made of irrigation projects that had to be abandoned. One of these was the North Dakota Pumping Project. Just a few miles from this project is the Lower Yellowstone Irrigation Project. This project also had a hard time at about the time the North Dakota Pumping Project was abandoned, but is at present one of the most successful projects in the nation. Less than 1 per cent of current construction and maintenance charges are delinquent, and there is little relief needed in the project area. Had the North Dakota Pumping Project not been abandoned, it would likely present a condition today comparable with the Yellowstone Project, and have saved the government many thousands of dollars in relief expenditures.

There is no climatic difference in these project areas. Your editorial would, I believe, contend that these projects are in the Great Plains area. It might be interesting to have someone delineate the Northern Great Plains, and the boundary line between the arid and semi-arid West.

The last paragraph of your editorial states in part, "Salvation of the Northern Great Plains lies in the rebuilding of grazing," etc. To insure the permanency of this industry a feed supply is essential, and this can only be assured by the irrigation of such areas as are susceptible to this development. The average annual precipitation in Western North Dakota and including the Lower Yellowstone Project varies from 14 to 16 in. The difference is not sufficient to eliminate the necessity for irrigation

where such is possible. On streams other than the Missouri River relatively large reservoirs would have to be provided. These can be constructed at from $5 to $15 per acre-foot of storage as compared to an average cost of present available storage in excess of $100 per acre-foot. Such reservoirs would provide flood protection, improved recreation and wild life facilities, and improved water supplies for municipal use and sewage dilution in addition to water for irrigation. Except for some benefits to recreation and wild life, the other benefits enumerated are not being realized from present facilities.

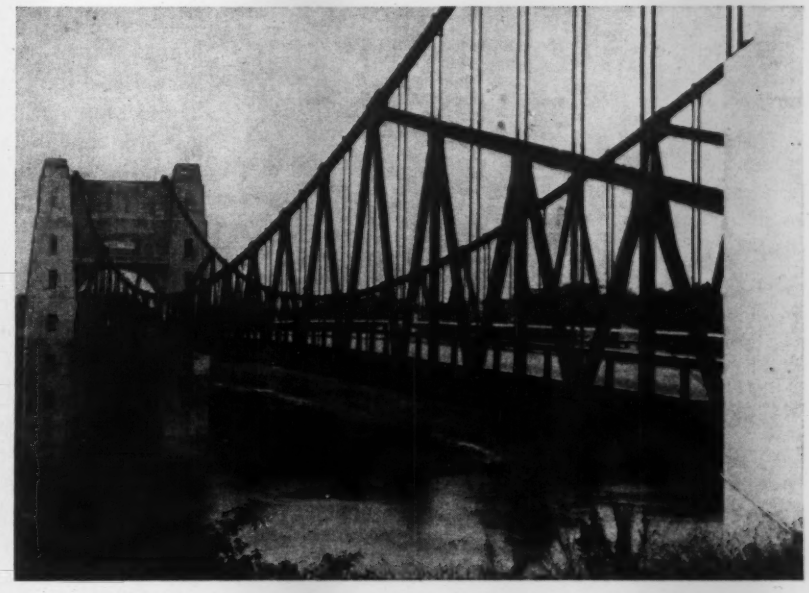
There is only about one per cent of the area in Western North Dakota that can be irrigated. This amount, however, will have a very important influence on its economic situation. There is a great need for engineers to take the initiative in promoting projects of real public benefit. This is too often left to persons who are not acquainted with the technical matters and physical limitations involved.

OSCAR BECKER
Staff Supervisor & Water Consultant
N. D. State Planning Board
Bismarck, N. D., Jan. 6, 1939

Unusual Suspension Bridge

Sir: Although the Indoroopilly Bridge over the Brisbane River in Australia is about three years old, the accompanying picture of it is the first I have seen. The main suspension span is 600 ft. long, and it is of the *Florianopolis type* in which the cable is used as the top chord of the stiffening truss over the middle portion of the span. It is the fourth bridge to be built of this type, its predecessors being the bridge at Florianopolis, Brazil and the Point Pleasant and St. Mary's Bridges over the Ohio River. But, instead of using eyebar chains as on the earlier bridges, the cables of the Indoroopilly Bridge are made up of the 2¾-in. wire ropes which were employed in the temporary anchorage during the construction of the Sydney Harbor Bridge. Each cable is made up of twelve of these wire ropes, arrang in four horizontal rows of three, spaced to give ready access for painting and inspection and for the insertion of the high tensile steel clamping bolts where the gussett plates of the top chord are secured to the cables.

The towers are of hollow concrete construction and accommodate the



Largest suspension bridge in Australia is of special type in which cables form top chords of stiffening trusses.

administrative offices. The cable saddles are supported on rollers enclosed in a steel boox packed with grease. The structure was built as a privately-financed toll bridge at a cost of approximately $425,000 which included the 1,305-ft. length of structure and 307 ft. of new highway approach.

D. B. STEINMAN
Consulting Engineer
New York, N. Y.

Bonus Payments

Sir: I note that in your editorial of Feb. 16, p. 46, relative to bonus payments for increased efficiency in concreting operations on work at Grand Coulee Dam, you state: "Now a single example is news; actual practice is almost unknown." This reminds me of an article I wrote on this subject and which you published in *Engineering News-Record* under date of Oct. 12, 1933, in that it was pointed out how improved quality was obtained in concrete through the payment of bonuses on sanitary sewer work in northern New Jersey.

M. H. KLEGERMAN
Associate, Alexander Potter
Consulting Engineer
New York, Feb. 20, 1939

Underwater Cutting

Sir: Being greatly interested in the progress made in underwater cutting I was interested in comparing the article "Cutting Cofferdam Piles At Riverbed Level" (*ENR* Dec. 15, 1938, p. 770) and the article "New Sheetpile Cutting Record Set for Underwater Work" (*ENR* March 11, 1937, p. 373).

In the Dec. 15, 1938, article, 29 sheets were cut in an 8-hr. day at 23-27 ft. depths, but in the March 11, 1937, article the contractors reached an average of 60 sheets in an 8-hr. day at 30-ft. depths, or doubling the rate of speed. The conditions were practically the same.

I thought you might be interested in the comparison and engineers and contractors would find it to their advantage to make more frequent reference to their filed copies of the *Engineering News-Record.*

ALBERT V. SIELKE
Consulting Engineer,
New York, N. Y.

Credit for the WPA

Sir: In the article written by me entitled "Chicago Park Passerelle", (*ENR* Jan. 5, p. 25) I stated that "WPA furnished some materials and common labor."

I have since learned that WPA furnished most materials, skilled and common labor, and I would like very much to correct my error and credit WPA with their part in this project.

LAWRENCE T. SMITH
Civil Engineering Dept.,
Chicago Park District
Chicago, Jan. 23, 1939

ENGINEERING NEWS-RECORD

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Volume 122, Number 13

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Editorial Offices at 330 West 42nd Street, New York

MARCH 30, 1939

STRONG ENCOURAGEMENT for the maintenance of an independent spirit in the management of public work is found in the record of Frederick Stuart Greene which was closed suddenly by death last week just after Colonel Greene had been appointed to his tenth term as superintendent of public works of New York State. Appointed superintendent of highways in 1919 by Governor Alfred E. Smith at a time when politics had penetrated deeply into the highway department, Col. Greene was forced out of office by a change of administration in 1919, but was reappointed two years later and soon was made superintendent of public works on his record of freeing the highway department of political influence and of putting it on an efficient working basis. Col. Greene stood in awe of no one. He spoke his mind freely and bluntly to everyone from the Governor down. Because his proposals produced results, though they often threw traditional methods into the scrap heap or injured people with strong political connections, he built up a reputation which gave his opinions unusual weight with legislators and executives alike. Greene's independence of thought and action approached the ideal that engineers have set up but seldom attain. That he succeeded should give new courage to many other engineers in public service who would resist the insidious pressure of those desiring to see sound engineering judgment step aside for partisan considerations.

Cheaper and Safer Roads

TWO SIGNIFICANT TRENDS appeared in the American Roadbuilders Association discussions at San Francisco, which centered largely about earth-road problems and traffic safety. Since earth roads mean lower costs, while safe roads mean higher costs, the two trends appear to conflict. Yet the discussions gave true expression to the growing demand that efficient road service, freed of unnecessary hazards, be provided at lowest possible cost. The country knows that a large part of the country's mileage remains unimproved, but it also knows that our most heavily used roads are congested and dangerous because of road inadequacy. These facts definitely point to the necessity of progressing toward methods of building smooth, all-weather roads for light traffic at low cost, and toward methods of building safe, large-capacity roads for heavy traffic even though at high cost.

Give the Facts

MAIN-ROAD RECONSTRUCTION, badly needed on many miles that have been paved in the last twenty years, bids fair to be strictly an engineers' battle for transport service. Nearly all other movements for highway improvement have popular acclaim. A program for farm-to-market roads, a campaign for highway safety measures or even a nation-wide express road system to rival Germany's best accomplishments can count on newspaper attention and active discussion by legislatures. If main-road reconstruction is proposed its lot is either silence or an implied opinion that road engineering has failed in its purpose. This is not merely a feared situation, it actually exists in a number of states and state road departments are having their troubles in meeting it. More than passive effort is needed. No road engineer has to be told that reconstruction of early main roads is widely necessary; in some states with well-developed systems it will call for the larger part of the road work and expenditure of the future. The problem of the highway engineer now is to make the public realize the facts. The highway planning surveys now being completed give him the means and there should be no delay in using them.

Open-Grid Bridge Decks

ANNOUNCEMENT that 95,000 sq. ft. of open-grid steel decking is to be used by the Connecticut state highway department on its new Housatonic River bridge gives point to some statistics recently compiled on this type of deck. It will be recalled that the first major installation of an open-mesh floor was made only about six years ago on the bascule span of the University Bridge in Seattle. Other installations came slowly, as was natural for a new product. In 1934 one installation is recorded, in 1935, three, in 1936, seven, and in 1937, seventeen. In 1938, however, engineers apparently began to accept this radical departure from traditional practice more generally because 60 bridges were equipped with this type of deck. Present installations are scattered in 20 different states and range

from small structures on farm-to-market roads to such large ones as the MacGregor Bridge in Manchester, N. H., the Marine Parkway Bridge in New York City, and the Housatonic River Bridge in Connecticut. In most cases, light weight has been the objective sought, but the non-skidding, self-cleaning features of the deck have also governed in others. It may be concluded that technically the open-mesh deck has met all of the requirements laid down for it and developed none of the objections that were raised against it. Unless the record of 1938 was an accidental piling up of orders, it may be said that a prophecy made in these pages in 1934 has come to pass, namely, that the open-grid floor will become an active competitor of other types of bridge floors. The record also indicates that new products may still enter established fields and make a place for themselves.

Bridges and Real Estate

IN the spirited discussion taking place in New York City on the subject of a vehicular crossing linking Manhattan and Brooklyn at the Battery, one question has been raised that has more than local significance. It is whether or not bridge approaches depreciate real estate values in their immediate vicinity, a question to which opponents of the bridge give an affirmative answer.

It must be left to New York City to decide whether it wants a bridge or a tunnel, or, in fact, whether any kind of a crossing is economically justified. Engineers generally, however, should be interested in the relation of bridges to land values. If the argument advanced by those favoring the Battery Bridge is sound, namely that a bridge approach in a wide right-of-way where it replaces solid-wall buildings with a graceful open bridge structure actually protects values, there is no problem. But if bridge approaches do depreciate adjacent real estate it is time that engineers sought a new type of approach design. It is not compatible with economic city development that attainment of needed improvements such as bridges should be accompanied by unnecessary losses in other municipal assets.

It would be well for city officials to examine real estate values in the vicinity of their bridges to determine what, if any, depreciation has occurred, and why. Where low land values exist, are they a result of the bridge or is the area inherently run down? If the bridge is at fault what elements of its design are most objectionable? What is the record of land values along the approaches of such modern structures as the Bay Bridge at San Francisco, the Triborough Bridge at New York or the Columbia Avenue Viaduct in Cincinnati, and what part does real estate operator psychology play in fixing these land values?

The answers to such questions as these are important. Modern bridge approaches tend to extend farther inland. Elevated highways are being discussed. The building of such structures will probably not be curtailed regardless of their effect on land values, but it is part of the engineer's responsibility that his handiwork aid progress in every direction possible. The present discussions in New York have raised a significant question to which the profession should supply an answer.

Pollution Abatement

HEARINGS have begun on the matter of a federal bill for stream pollution control, following the introduction of two measures in Congress. Such legislation has the active support of President Roosevelt who several weeks ago submitted a special message to Congress urging the adoption of a federal policy of technical aid and financial assistance to curb water pollution. The stage is set, therefore, for the passage of legislation.

Of the two bills under consideration, the one proposed by Senator Barkley (S 685) best fits the needs of the problem: It would set up a board selected from the U. S. Public Health Service to cooperate in studies with state and municipal agencies; the board would pass on and approve projects; and it would supervise a program of federal grants and loans. The substitute bill proposed by Senator Clark (S 1691) must be viewed with misgivings. Although federal grants in aid would be liberalized, the bill seeks the establishment of a section of water pollution control in the Corps of Engineers and the division of the country into local sanitary districts wherein compulsory standards of water purity would be established.

The Barkley bill is free from these elements of compulsion. And furthermore, in specifying the Public Health Service as a coordinating agency, it utilizes an existing arm of the government service which has for many years made notable contributions to, and understands, stream pollution abatement. It is to be recalled, too, that a measure almost identical to the present Barkley bill won approval of Congress last year, missing enactment into law only because of a Presidential veto on a technicality. The soundness of the Barkley bill justifies its support by all who favor pollution abatement.

Curtiss-Wright Photo

FIG. 1. WINDOWLESS FACTORY OF SIMONDS SAW & STEEL CO., FITCHBURG, MASS. COVERS A 5-ACRE PLOT.

Finishing a Famous Factory

Contents in Brief — First windowless factory, built in 1931 by Simonds Saw & Steel Co. at Fitchburg, Mass., is just now being put into service. Gas flue tunnels, underfloor power ducts, drainage lines, water pipe, overhead lighting and air conditioning facilities as well as machine foundations and concrete and wood block floors are among the items in the finishing contract.

In 1931 when the Simonds Saw & Steel Co. started construction on a windowless, solid masonry-wall industrial building in Fitchburg, Mass., the event was marked by widespread publicity. As the first windowless factory it was discussed by industrialists, engineers, doctors, psychologists and others, each of whom praised or condemned it according to his viewpoint of the moment. The depression stopped work on the Simonds plant after the frame, roof and walls were completed, and it stood idle until last summer when a contract was let to finish it. In the meantime, numerous windowless factories had been built, but all used glass block and not brick or masonry walls. The Simonds plant when it goes into production in June thus will still be the first truly windowless factory to be built in this country.

Present interest in the Simonds building centers in the installation of utilities and in other finishing operations, but a brief review of what it is, and why, is pertinent. The building is 360x560 ft. in plan, one story high, of steel frame construction with welded roof trusses. Bays are 70x40 ft., providing eight 70-ft. aisles across the width and nine 40-ft. aisles lengthwise. There are only 56 interior columns in the 5 acres of floor space. Such a plant was planned to achieve straight line production for facilities now housed in three separate buildings of multi-story type; each production line will, in fact, contain all equipment, including heat treating furnaces and forges, necessary to turn out a given product.

Walls consist of 9-in. hollow cinder block faced with common brick, giving a total thickness of 13½ in. The flat roof is a steel deck of perforated channel units, the channels being filled with a 1½-in. layer of slab cork, covered with two ½-in. layers of fiber insulating board and topped by a three-ply felt roofing.

The cinder block walls and the perforated roof deck were adopted to get the necessary acoustical control in an inclosed building where there will be no partitions to separate the noisy from the more quiet operations. The advantages sought by the windowless walls were controlled atmosphere and lighting to the end that working conditions could be maintained for maximum and uniform efficiency throughout 24 hours of the day.

Air conditioning equipment of the evaporative cooling type is housed in four wings, 28x94 ft. in plan, placed at the quarter points of the long sides of the building (Fig. 1). Air is drawn in through louvres in the walls of these wings, while 52-deg. water for cooling and humidifying uses is obtained from deep driven wells just

outside of each of these utility wings.

This, in brief, is the building into which the contractor moved his men and equipment last summer to lay a concrete floor and to install foundations and utility services for about 1,000 machine and furnace locations. Among the pipe items required are 10,000 ft. of cast iron, 7,000 ft. of welded steel, 10,000 ft. of black iron, 5,600 ft. of galvanized iron and 6,000 ft. of brass, about equally divided between underground and overhead installations. Also required to be buried in the slab are 17,000 ft. of rectangular power ducts (for 440-volt current), placed on 10-ft. centers with access openings every 2 ft.; and 60,500 ft. of galvanized conduit for 110-volt lighting circuits.

Construction operations were carried on piecemeal throughout the entire floor area, inasmuch as every machine foundation had to be special to fit the equipment that will be moved in from the old plant. Foundation material being clay underlaid with gravel, all excavating could be done with hand tools, and was handled most economically by that means. The largest excavation job consisted of trenches for three 4 x 5-ft. concrete flue gas tunnels connecting the heat treating furnaces to an underground fan room from which the gases will be exhausted to the outdoors.

As each section of floor is graded, forms are built for any special machine foundations, rod reinforcement is installed on chairs made of short pieces of rod reinforcement, and power, water, steam and quench oil pipe and lighting conduits are placed in proper positions. From grinding and other dust producing machines, it has also been necessary to install concrete underfloor ducts leading to some 30 central dust removal units.

Fig. 2. Before finishing operations began. Note air conditioning ducts. Lighting units shown are being replaced with fluorescent tubes. Inspection walkway at left extends entirely around building.

Ready-mixed concrete is purchased from a commercial plant, small quantities, 25 to 250 yd. per day, and intermittent requirements making it uneconomical to set up a central plant. The larger pours are made on Thursday so that the week-end will be available for curing, a minimum of five days being specified for the slabs. The even temperature in the building makes for ideal curing conditions.

Concrete was specified as a 1:2:4 mix, with water regulated to produce a 3,000-lb. strength at 28 days; average attained strength has been 3,800 lb. For machine foundations, where bars are often closely spaced, a 2½-in. slump mix is used, and its placement aided by vibration. Finishing is by wood floats and steel trowels.

The slab, 6 in. thick, is covered, except in certain heavy-operation locations, by a 2-in. wood block floor laid in mastic and with poured asphalt joints. All machine foundations are separated from the floor slabs by ¾-in. premolded asphalt joints. Similar joints are used in the slab to inclose areas of about 1,600 sq.ft.

With the slab and underfloor facili-

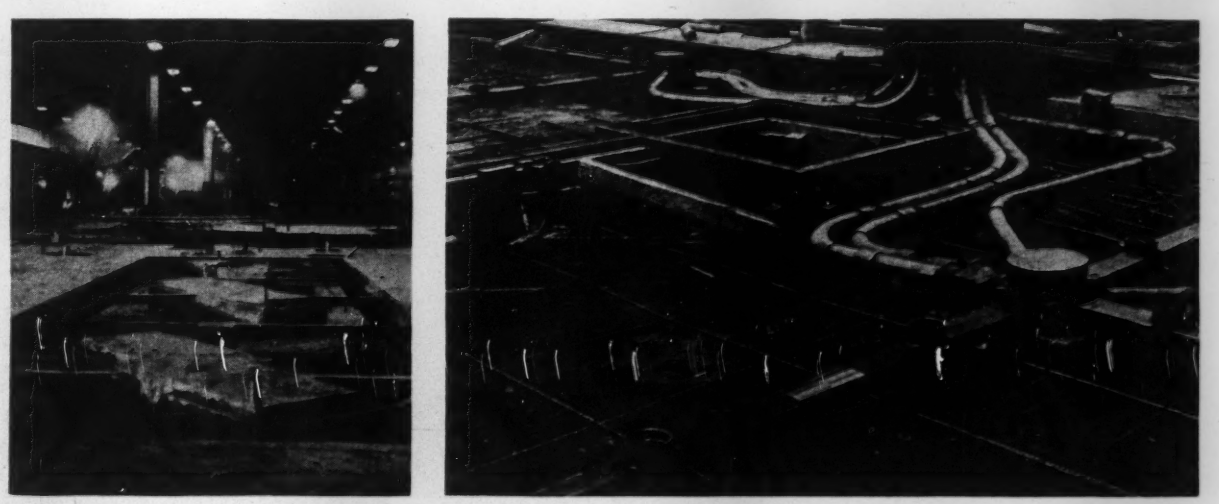


Fig. 3. All utilities are buried in the floor slab (right), and special foundations were required for all machines (left). In background of left view one of the large heat treating furnaces is being installed.

ties well under way, work was begun on completing the previously installed air conditioning and lighting systems. Also leader lines from the underfloor systems were run up beside columns to headers and bus bars carried on the lower chords of the trusses. The six-year delay in finishing the plant has permitted advantage to be taken of recent developments in air conditioning and lighting equipment so that the final installations are more efficient than those originally specified. Air conditioning ducts, totaling 3,000 ft. in length, branch from each of the four utility rooms. The ducts are of copper-bearing steel in 16- to 20-gage thicknesses and vary in size from 68x90 in. at the inlet to 26x20 in. at the outlet. Air is discharged downward through baffled ports located at intervals along the duct lines. All used air in the building (except that from the furnaces, which will be caught in hoods and carried out through the flue gas tunnels) will be exhausted through 42 ventilating hoods in the roof located above the furnaces and other heat generating equipment where aprons of corrugated cement asbestos board extending downward from the roof to the lower chord of the trusses trap the heat. The rapid exhaust of heat in these locations is counted upon to pull the cooler used air from other points in the plant to these same outlets.

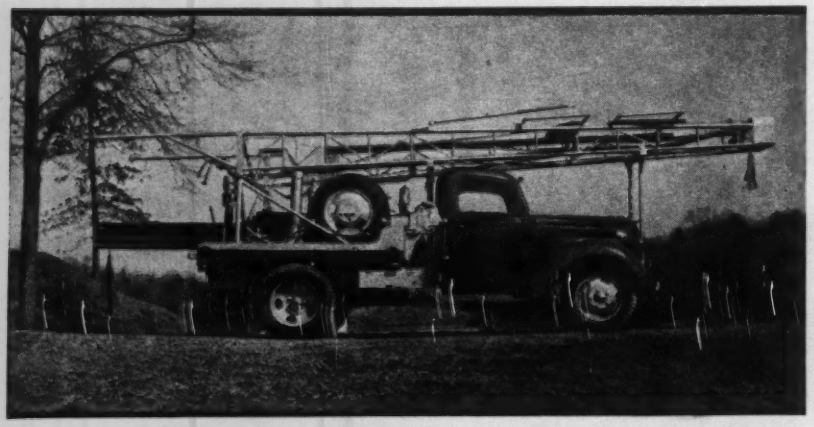
The lighting fixtures are of a new and revolutionary type providing 50 lumens of light per watt. They consist of a 1,000-watt fluorescent tube 1 in. in diameter and about 4 ft. long hung horizontally below a half-cylinder porcelain reflector. The lighting units will give about 20 ft. candles of non-glare "daylight" illumination on the working plane. The light is blue-white in color with enough red rays present to keep colors of objects natural. About 1,440 of these lamp units will be installed in the plant at a height of 16 ft. above the floor, that is, 2 ft. below the bottom chord of the trusses.

The original plant was designed and built and the present contract is being carried out by the Austin Co., Cleveland. N. R. Crater has been construction superintendent on both jobs.

Hydraulic-Feed Soil Sampler

Better undisturbed soil samples are assured by hydraulic control of drilling speed in new traveling rig

A CORE DRILL-RIG that has advantages in taking undisturbed soil samples is shown by the accompanying illustration. The machine was developed by the soils-mechanics division of the U. S. Waterways Experiment Station at Vicksburg, Miss., and a machine of similar construction but mounted on skids has been used successfully for some time by the army engineers of the Second New Orleans District for soils exploration on the Atchafalaya River improvement. The operation and performance of the drill has been well tested also in the Vicksburg, Jacksonville and Mobile engineer districts.



New mobile sampling drill-rig of the army engineers with hydraulic drill feed which provides more perfect soil samples.

On a 1½-ton truck chassis are mounted a hydraulically-controlled collapsible 24.5-ft. mast (shown lowered in the picture); draw-works consisting of hoisting drum and cathead; a retractable rotary drill-head equipped with a high-pressure hydraulic feed of 30 in. travel; a 75-g.p.m. slush pump, and a power take-off from the truck transmission that drives the draw-works, the rotary head, the slush pump and the hydraulic pump.

The principal advantages that the equipment possesses are mobility, convenience of operation and rapidity of drilling. The mobility of the rig may be illustrated by the fact that exploration and sampling near Clewiston, Fla. (Jacksonville Engineer District) was in progress less than a week after telephonic authority was received to proceed from Vicksburg. Convenience of operation is gained by grouping all controls within easy reach of the driller. Rapidity of operation over other types of machine-driven rigs is gained principally through the use of hydraulic feed. Speed of drilling can be adapted to the type of material to a degree not possible with screw-feed machines and changes of material can be more easily detected.

The hydraulically controlled machine is adaptable to every variety of sampling that is met with ordinarily. The superiority in obtaining undisturbed samples is that the sampling tube can be jacked slowly into the sampled stratum, rather than driven down by a series of sharp blows. Fish-tail bits may be used for rapid drilling (about 50 ft. per hr.) to rock, or to any desired depth above which sampling is unnecessary. Rock cores may be obtained by any of the conventional type core bits. Depths to which the equipment may be used vary with the size of the hole: 6 in. diameter, 600–700 ft.; 4-in. 750–800 ft., and 3-in., 1,000–1,500 ft. This information has been furnished by the waterways experiment station, 1st. Lieut. Paul W. Thompson, Corps of Engineers, Director, Vicksburg, Miss.

Concrete Superstructure On Steel Bridge

Contents in Brief—Latest addition to Montreal's river crossings, described in a paper (of which this article is an abstract) before the Montreal branch of the Engineering Institute of Canada by S. H. Beaulne, consulting engineer, consists of six steel arch spans supporting concrete spandrel columns and deck in which welded structural reinforcement is used. Bridge was erected by a traveler operating on the reinforcing.

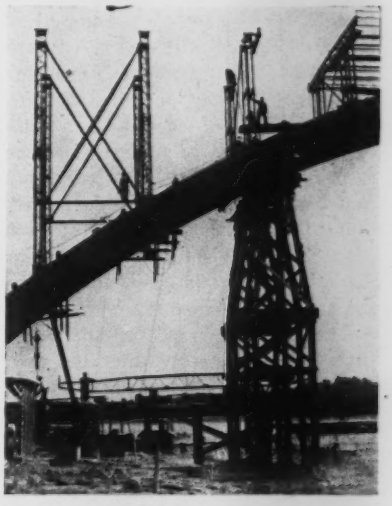
OPENED TO TRAFFIC last year, a new crossing of the Rivière des Prairies at Montreal, known as the Pius IX Boulevard Bridge, is notable for its use of two-hinged steel arch ribs to support a concrete superstructure incorporating welded self-supporting steel reinforcement. The main river crossing consists of six arch spans varying in length from 103 to 324 ft., with each of the end arches unsymmetrical. The ribs are 25 ft. apart, center to center, and a 30-ft. roadway and two 6-ft. sidewalks are accommodated on the deck, which is built on a rising grade of 1.71 per cent. Six 95-ft. concrete arch spans comprise the south approach, while the north approach is at grade.

Each arch rib is of box section, 3½ ft. deep and 8 ft. wide, the latter dimension being determined by required lateral stability when unbraced and by the width necessary for the pairs of spandrel columns which rest on each rib. Transverse diaphragms at each panel point and three lines of longitudinal bracing provide support for the wide top and bottom plates.

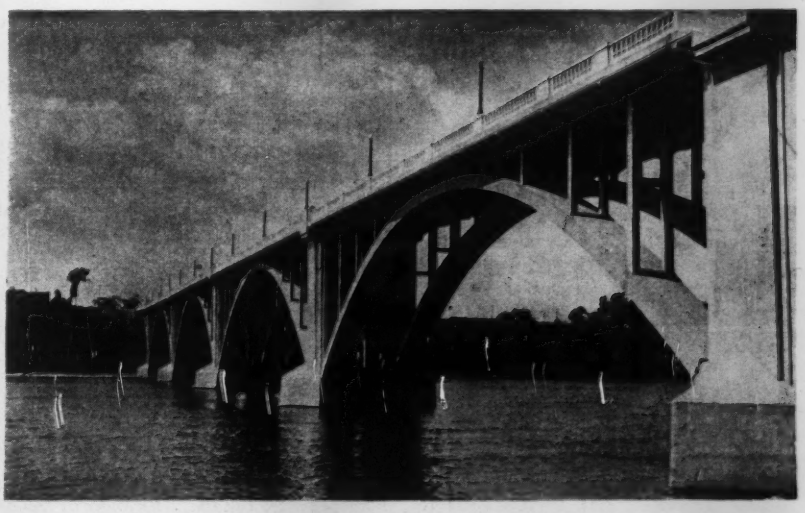
Special treatment was required for the 103-ft. unsymmetrical span at the south end, since its end pins as well as the hinge of the adjacent concrete approach span are at an unusual height above the base of the pier, with the thrust from the approach span being considerably the greater. To resist this unbalance, the hollow steel rib was filled with concrete which increased the thrust from this span and also made the rib adequate to transmit the remaining unbalanced thrust to the first river pier.

The concrete superstructure carried by these steel ribs consists of four-post bents (two posts to each rib) supporting floorbeams which in turn carry 21-ft. span stringers spaced at about 6-ft. centers. The deck is an 8½-in. concrete slab, including a 1½-in. cement wearing course. The welded structural steel reinforcing for the concrete superstructure was designed to carry the construction loads, which were found to govern the size of the top chord angles and web system of all floorbeam and stringer trusses. Web members of these reinforcing trusses consist of rectangular bars or single angles chosen to fit into a 2-in. space separating the double flange angles. Spandrel column reinforcing consists of 2x2½-in. angles laced on four sides. All long posts are tied together to reduce their unsupported height and are 14 in. wide in the direction of the ties, varying in the other direction with their height.

The steel was fabricated, both arch ribs and reinforcing trusses and posts, at the Lachine plant of the contractor and trucked to the site. The general scheme of erection was to erect the rib and deck steel on timber bents resting on the rock of the river bottom and to adjust the closure of the arches by jacks placed at the top of each timber bent. Span 1 was erected with a 12-ton guy derrick with a 90-ft. boom which remained in



Erecting welded structural steel reinforcing for concrete columns and deck of Pius IX Boulevard Bridge.



Half-and-half describes the Pius IX Boulevard Bridge in Montreal. Arch ribs are steel, columns and deck are reinforced concrete.

place to handle material from the incoming trucks onto the job service trucks. This derrick was also used to erect a 12-ton deck traveler which placed the other spans.

This traveler operated on the welded reinforcing of the deck system which it placed in position on the arch ribs as soon as these were erected. In all the main river spans the two end rib sections first placed were erected on a harness tied back to the pier structure. Thereafter rib sections were supported by the falsework until final jacking was done. Temporary horizontal bracing between ribs was used to stiffen the structure during erection. Also, temporary vertical bracing between the posts was required. The steel reinforcing for the towers on the piers, being connected with the rest of the structure only through expansion joints, required independent bracing on four sides of each tower. Some of this was left in place as permanent reinforcing but most of it was removed and wood bracing substituted before the pier concrete was placed. Field riveting was done immediately after jacking and before the falsework was removed.

The concreting of the superstructure followed closely after the erection of the arch steel. Mixing was done on shore and concrete was transported along the bridge by a two ton truck running in a special troughed runway blocked up from the steel of the deck.

The construction sequence adopted required that the concrete in the spandrel columns be placed up to the bottom of the floorbeams and allowed to set before deck concrete was placed. This limited the construction loads on the steel reinforcing in the columns to the erection traveler and its track plus the weight of the deck reinforcing.

To aid the erection and removal of deck forms, a platform was built underneath the deck steel extending the full width of the deck and supported on light shores from the arch ribs. In addition to its primary purpose, this platform also acted as an excellent safety device. After the column concrete had set, the floorbeams, stringers and decks were next concreted in order, care always being taken to advance all concrete symmetrically about the center line of the span to eliminate the possibility of unusual deflections or bending stresses.

Field painting of the spans consited of two sprayed-on coats of gray paint. While the second coat was still wet, the surface was sprayed with fine white sand, which gave a finish very similar to the concrete of the deck system.

The bridge was planned and financed by the department of public works and labor, Province of Quebec, for whom S. A. Beaulne was consulting engineer. The general contractor was the Dufresne Construction Co., Ltd., Montreal, and the subcontractor for the supply and erection of all steelwork was the Dominion Bridge Co., Ltd., Lachine, Quebec.

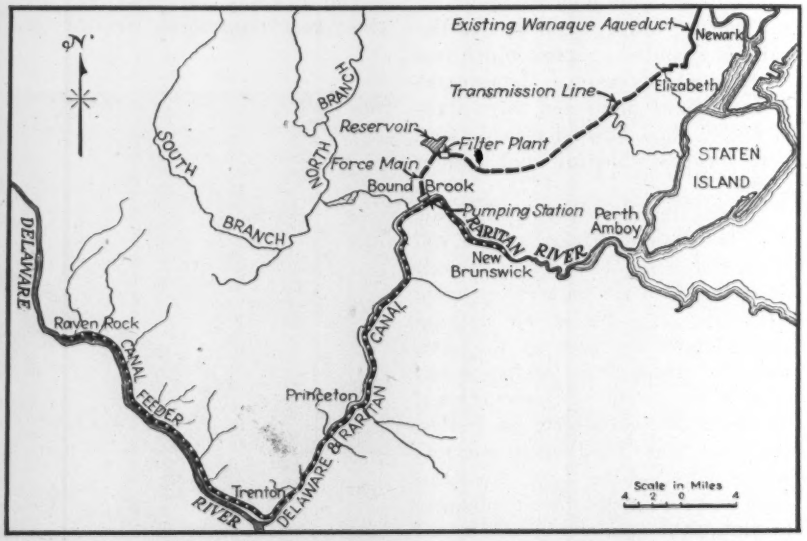
Delaware Water for New Jersey

An aqueduct in an abandoned canal is proposed for diversion of river water to a central point in the state

CONSTRUCTION of an aqueduct in the abandoned Delaware & Raritan Canal as a feeder for a new water supply from the Delaware River for the metropolitan district of New Jersey has been recommended to the state legislature. River water would flow by gravity through a 49-mile closed aqueduct to Bound Brook and then be pumped to a 600-m.g. storage reservoir. After passing through pressure filters the water would enter a 21-mile 200-m.g.d. transmission main which would be tied into the existing Wanaque system now serving a large part of northern New Jersey.

The report recommending this plan was prepared by a committee, appointed by Governor A. Harry Moore, consisting of Charles H. Capen, Jr., engineer of the North Jersey District Water Supply Commission; H. T. Critchlow, engineer of the State Water Policy Commission; and H. P. Croft, engineer of the State Department of Health. In their report the committee considered three plans of utilization of the canal, these plans varying in cost from $29,400,000 to $33,700,000, depending upon the extent to which the canal is covered.

The advantages of using the canal



New water supply project for New Jersey which will tap the Delaware River. The plan provides for the utilization of the Delaware and Raritan Canal to bring water to a pumping plant at Bound Brook, with gravity flow to a connection with the Wanaque system near Newark.

are that the state already owns the right-of-way, and by acquisition of the canal property is said to possess the water rights originally conferred upon the canal company. The latter permit diversion from the Delaware River without the consent of Pennsylvania. While the amount of diversion is not stated, official records show that the canal company used as much as 210 m.g.d. for navigation. The private company built the canal about 1830, and upon its abandonment in 1934 the state took possession.

The favored plan

The plan favored by the engineers submitting the report contemplates a closed concrete aqueduct flowing under low pressure for the entire distance of 49 miles from Raven Rock to a point near Bound Brook, where the connecting line leading to the pumping station would take off. This type of acqueduct would exclude all cross drainage, stormwater and polluting material. Furthermore, it would eliminate leakage and evaporation losses amounting in the summer period to over 100 m.g.d. Twin conduits of rectangular section are recommended for the aqueduct because of the shallow depth of the old canal and the low clearances at highway crossings en route, particularly through the city of Trenton.

A pumping station would be located at the end of the aqueduct to lift the water into the storage reservoir. For this purpose there would be ten pumps, each of 20 m.g.d. capacity. From the pumping plant to the reservoir, a distance of about 4 miles, the water would be conveyed through a 9-ft. single pressure pipe line of steel and a one-mile concrete lined tunnel.

It is proposed that a dam be built in a narrow gorge at Dock Watch Hollow where an available storage of about 600 m.g.d. could be obtained with a drawdown of about 20 ft. The dam would be of the concrete gravity type, and it is recommended that the design be such that the height may be raised in the future. An additional 80 ft. of height would create an available capacity of about 15 billion gallons.

Pressure filter plant

Because it may be found desirable in the future to raise the height of the dam in order to create more storage, the engineers stated that pressure filters would be more desirable than those of the gravity type. Filters of 30 ft. in length and 9 ft. diameter are proposed, each having a capacity of about 1 m.g.d. Two hundred such units would be required in order to meet peak demands, the units being arranged in banks of 25, with 13 units on the ground floor and 12 units supported above the 13. Two such banks comprise a group, and four groups would be required for the entire plant.

A coagulation basin would be constructed between the dam and the filter, and nearby a chemical building would be located for storage purposes and to house the feeding equipment.

The transmission main

To carry the water from the reservoir to the coagulation basin and then to the filters, a pressure pipe of about 9 ft. in diameter and 1,000 ft. in length is proposed. From the filters two pipes of 6 ft. dia. each are used, going in a generally southeasterly direction. At the northern side of the first range of Watchung Mountains the pipes enter a 9-ft. dia. tunnel about 3,500 ft. in length. From the southern portal of the tunnel two 6-ft. pressure pipes will carry the water to Newark, where a connection can be made to the Wanaque system.

Cost estimate

It is estimated that the cost of such an aqueduct would be $15,000,000; the pumping station $1,046,000, the dam (including real estate) $2,835,000; the filter plant $3,087,000, and the transmission line about $9,000,000. The capital cost therefore totals about $33,700,000. Annual operating costs for the project are placed at about $1,125,000.

The cost of the Delaware River acqueduct is considerably under that of two other projects previously considered by the legislature. One of these, the Bunnvale project, has an estimated cost of $47,945,000, and the other, the Chimney Rock project, has an estimated cost of $51,994,000.

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Soap and Water Softening

In a comparison of water softening by soap in the home and by chemicals at a waterworks plant, given in a paper before the South Dakota Water and Sewerage Conference, by Charles H. Spaulding, supervising chemist of the Water, Light and Power Department at Springfield, Ill., it was estimated that probably more water is softened individually in homes, shops and offices than by chemicals at large plants. To remove one pound of calcium hardness requires about 12 lb. of soap, but only requires 0.6 lb. of 93 per cent lime if equivalent bicarbonates are present in the water, or 1.08 lb. of 98 per cent soda-ash if bicarbonates are not present.

Even the cheaper grades of soap cost at least 15 times as much per pound as equivalent lime and ten times as much as soda. Therefore, to remove calcium hardness from water with soap costs from 100 to 3,000 times what it costs to remove it with lime and soda, depending on the relative amounts of the chemicals required. Magnesium requires a double portion of lime for its removal if equivalent bicarbonate is present, or one equivalent each of lime and soda if it is not present. Even so, a dollar spent for the chemicals will do as much as $80 worth of soap in magnesium removal. These values are based on lime at 0.75¢ per lb., soda at 1.2¢ and soap at 12¢ per lb. Such calculations show, says Mr. Spaulding, that a community which used only 1 per cent of its water in cleansing operations would still be money ahead if it softened its water supply.

More convincing evidence may be had from surveys of soap consumption in several cities: in Chicago Heights, with a hardness of 555 p.p.m., people spent $7.27 per capita per year for soap; in Champaign-Urbana, where the hardnes was 298, the expense was $5.58, while in Bloomington, with only 70 p.p.m., the cost was only $4.20. At this rate, a difference of 110 p.p.m. in hardness of city water is worth 62¢ per capita per year. Thus, if water of 200 p.p.m. is reduced to 100 p.p.m. it will save the community $6,200 per year for each 10,000 of population.

New Public Works Department For New York City

ADOPTION of a new charter by the City of New York last year reorganized the municipal government for greater efficiency and brought into being for the first time centralization of public works in a single department. The three major activities which have been consolidated in this department are public buildings, bridges and sewage disposal. All design, construction and operation of these works are thus brought under one authority.

It has taken four decades to reach this present form of public works organization. Heretofore, bridges were handled by independent departments, public buildings were handled separately by each of the five boroughs, and sewage disposal was a division of the Department of Sanitation. The Department of Bridges (later called the Department of Plant and Structures), incidentally, was the first citywide department dealing in public works. It was created in 1898 when Greater New York was formed by the consolidation of Manhattan with Brooklyn, and the counties of Bronx, Queens and Richmond.

The new Department of Public Works is charged with the design, construction and operation of bridges over navigable waterways, (excepting, of course, those bridges which are under the jurisdiction of special authorities created by the state legislature). It performs also the same function with regard to public buildings, sewage disposal plants and intercepting sewers, except that such buildings as police stations, fire houses, health stations, hospitals, welfare clinics, public markets, garages, and incinerators are operated by the departments controlling these specific functions.

The manner in which the lines of responsibility radiate and the structural arrangement of the department with its personnel is indicated in the diagram. This is a typical "line and staff" type of organization pattern. It provides for the use of specialists, yet centralizes control with the executive heads. And throughout it definitely fixes duties and responsibilities.

All technical functions are centralized in a division of engineering, which is composed of four special service agencies and four bureaus, with a fifth bureau contemplated. The service agencies are: topographical (surveys and map work); contracts (preparation of contract documents); motor vehicles; and materials testing.

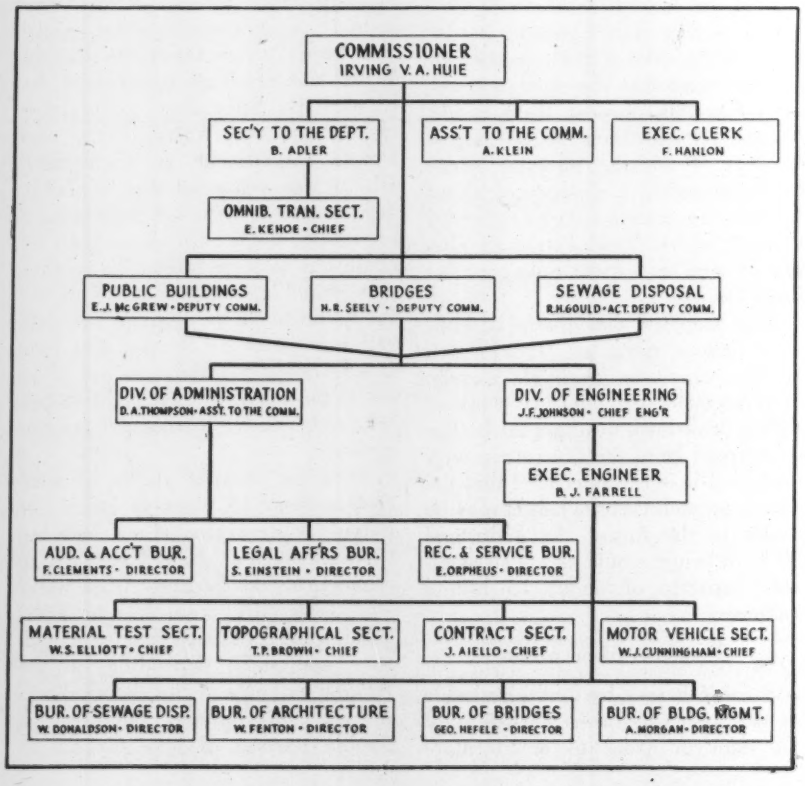
In the bureaus we have the "line" element of the organization. There is a separate bureau of sewage disposal, of bridges, of architecture, and of buildings; eventually a bureau of construction will be added. For sewage disposal and bridges there are separate design, mechanical, electrical, construction and operating groups. The building bureau, however, is purely an operating agency, while architecture includes a design, mechanical, electrical and construction section.

To carry out the work of keeping records, payrolls and other clerical activities for the entire public works department, a division of administration has been provided.

The personnel of the department numbers 3,632 people, of which 625 are assigned to engineering, 2,800 are engaged in operating functions, and about 200 are clerical workers.

It will be noted that several activities generally classified as public works in other cities are not included in the New York City Department of Public Works. Street cleaning and refuse disposal for the five boroughs, for instance, are in the Department of Sanitation which was established in 1929. Parks and parkways are administered by the Department of Parks, a citywide organization which came into being in 1934. Docks and terminal facilities are in the Department of Docks. And the distribution and service requirements for water supply are handled by the Department of Water Supply, Gas and Electricity.

Streets and all sewer work (excepting interceptor sewers) are carried out by each borough, each maintaining an independent engineering and construction organization for this purpose.



Roadbuilding Facts and Opinions

***Contents in Brief**—Current roadbuilding knowledge and experience formed the subject-matter of nearly a hundred papers and reports presented at the San Francisco convention of the American Road Builders Association two weeks ago. A few of the contributions are condensed in the following abstracts. It is timely to note here that the arguments for express-road or superhighway construction as presented by M. D. Van Wagoner and C. M. Upham in the first two abstracts below received support by resolutions of the Associated General Contractors, which also met at San Francisco.*

Superhighways the next need

AS A WHOLE, our highway improvement program has consisted of doctoring up our old wagon roads and attempting to make them accommodate the automobile. The result has been an inevitable conflict in automotive traffic movement that has brought intolerable congestion and a shocking casualty and property damage toll. In most sections, revenues have been so restricted that highway administrators have not even been able to provide the old wagon roads with a suitable surface. In many others, highway revenues have been used to finance other functions of government while our highways have been suffering.

Against this picture of restricted revenues is the knowledge of unusual expense involved in the construction of limited-access highways or superhighways. A recent computation in Michigan shows that this construction will cost $300,000 per mi. in rural areas and $1,600,000 in urban sections, including terminal facilities in our larger cities. At the same time highway administrators cannot escape the responsibility that is ours in providing for this need. It must be met—somehow and some way.

It is my recommendation that Congress provide for a billion-dollar revolving fund to finance superhighway construction in the United States over a period of the next twenty-five years. The revolving fund would offer a guaranty that the program, once started, would not be abandoned. A toll charge sufficient to pay for the construction, maintenance, and administration of such highways could be levied; the average charge should not exceed 1c. per mi. Or, a low toll supplemented by gasoline tax earnings on the superhighway could be used for financing these roads. The alternative is a 1-cent increase in the federal gasoline tax to be used exclusively for superhighway construction, maintenance, and administration.

The superhighway program should start with the urban development. First should come the construction of terminal facilities, followed by the projection of the superhighway to the end of the urban zone; last should come the rural section of the superhighway. Selection of routes should be cautious; no route should be chosen unless there is conclusive evidence that traffic volume justifies such construction. These routes should follow the same general routing as existing highways with heavy concentrations of traffic.

Right-of-way not less than 1,500 ft., and perhaps wider, should be obtained throughout the rural sections. Investigations in Michigan show that the original price of the 1,500-ft. rural right-of-way would not greatly exceed that of say a 300-ft. right-of-way.

In every city of the country, by reason of industrial and business development, there are entire blocks of "blighted property" in the central business areas. It is my recommendation that Congress create a Federal Land Authority empowered to negotiate for entire urban business blocks as well as large rural acreages for federal construction projects, including superhighways. The authority would also be empowered to sell the excess property not used for such public improvement developments.

Twenty-five years from now our children will look back with the same recollections of horror of present-day traffic congestion that we recall in reflecting upon the nightmare of mud roads of our own youth. Every experience of the past 25 years convinces us that such a program can go forward. And every concern for the future convinces us that it must go forward.—MURRAY D. VAN WAGONER, *Michigan highway commissioner.*

A national highway system

A system of national highways could be economically constructed in this country over a period of time and in such a manner that the present-day congestion on the highways that is costing us so much money could be immediately done away with. Highway facilities would be afforded to the districts in which there are high traffic demands. The hazards of the highway could be removed and safety built into the highway, thus saving lives. The whole could be paid for by the present taxes that are now being collected from the highway user. Such a program is entirely feasible and practicable, and if followed in an economic manner would in a period of from 20 to 40 years afford this country a national highway system, an economic means of communication and transportation, and there would immediately accrue to the country a solution of its present-day economic ills.—CHARLES M. UPHAM, *engineer-director, A.R.B.A.*

Soil studies for high fills

Laboratory control must be closely tied in with field work in foundation drainage and construction of fills. Physical analysis of materials is important with respect to bearing value under different conditions. Recent additions to knowledge of how various soils will act when load and moisture content changes provide means for making safe fills of a size that would have been impractical or

impossible without this knowledge. Adequate foundation preparation is essential before a high fill is built. For example, 50,000 cu.yd. was removed from the site of a fill in the north approach to the Golden Gate Bridge. The essentials of preparing for deep fills are: (1) removal of unsuitable material, (2) setting a suitable "strut" at the toe, and (3) adequate drainage; the last named is the most important. A 10,000,000-cu.yd. highway fill now under way in California is being built by the hydraulic sluicing method (one 7-in. and one 8-in. nozzle under heads exceeding 500 ft.) at a cost of less than 3½c. per cu.yd. Other large filling operations include 1,250,000 cu.yd. in 3½ mi. on the Questa grade; 2,250,000 cu.yd. in the 6½-mi. Santa Cruz Mountain route, and a single 120-ft. fill of 300,000 cu.yd.—O. J. PORTER and R. M. GILLIS, *senior testing engineer and construction manager, California Division of Highways.*

Hand and machine airport paving

Several million square feet of airport runway surfacing of asphalt stabilized soil and rock is being laid at the San Francisco airport by the WPA, using both hand and machine mixing. Excellent service results are being obtained from pavements laid by both methods, but machine work simplifies the process and lowers the cost. Work began about three years ago and is still in progress.

For the hand work, garden tools served as equipment—five-pronged potato rakes, 3-gal. pouring cans, picks, shovels, 8-lb. hammers, and wheelbarrows without sideboards. The ground between headers set 9 or 10 ft. on centers was loosened by picks and shovels to subgrade depth and the emulsion proportioned with water was applied by pouring from the 3-gal. cans. Four to six men were used for carrying emulsion and one man for pouring. Crews of 6 to 8 men mixed the aggregate, using the potato rakes. The stabilized material was worked backwards, screeded to header grade, but the mixture was not uniform in thickness; the boys just didn't reach bottom with their hand scarifiers. Carrying the excavation far in advance of the stabilizing gangs, and windrowing the aggregate, gave uniform thickness and better progress.

Hand-mixing requires considerably more water than is necessary to carry the asphalt. It was ten days to two weeks before some of the pavement would take a roller. In warm weather the excess water caused shrinkage cracks which in no way affected the pavement, as the cracks closed up under the roller and were effectively closed with the application of the seal coat.

Pavement has been open to traffic since July 1936, and receives impact of large ships weighing 24,000 lb. This will be its third winter and as yet no failures have occured.

Machine mixing—Part of the paving had to be made of quarry-run aggregate brought from a distance. A stationary pug mill along a railroad siding was obtained, and here the material was batch-weighed, and emulsion and water weighed in exact proportion, before transporting to the field. Here it was dumped into the screed panels, hand-screeded to grade, and usually rolled at once.

With water controlled to the point of just permitting distribution of the emulsion and giving good workability, or 7.5 to 8 per cent water, rolling could be started immediately after placing and screeding. The emulsion averaged 3½ per cent of the dry weight of aggregate. With control of the fines passing the 200-mesh sieve we did not make any attempt to grade the aggregates of the quarry and the results have been most successful. After all, the 200-mesh material is stabilized, not the rock. The answer is, make the mix workable.

Traveling mixer—When wider and longer runways with greater crowns were required, the earth was stabilized and placed by a traveling mixer, that picked up aggregate from one windrow and deposited the stabilized aggregate in another windrow, while accurately metering the emulsified asphalt and water. This plant has simplified the process and lowered the cost.

Progress—Hand mixing laid about 7,150 sq.ft. of 4-in. pavement per day of 8 hr. The stationary mixing plant laid 34,000 sq.ft. of 4-in. pavement in 12 hr., while the traveling mixer laid 54,000 sq.ft. of 4-in. pavement in 8 hr.—A. J. WEHNER, *construction engineer, San Francisco airport.*

Pressure on subgrade

Loading tests conducted during the past two years at the University of Washington give some data on the effect of the thickness of gravel and crushed-rock roadbeds, both with and without binder, on pressure transmission to the subgrade. Two subgrades were used, sand and blue clay; roadbeds were 4, 8, and 12 in. thick. A Goldbeck pressure cell embedded in the subgrade served to measure the load transmission under an applied pneumatic tire load of 910 lb. placed either directly over the gage or at 1/10 ft., 2/10 ft., etc., to one side, to develop the shape of the pressure distribution curve.

The pressure readings gave an inverted bell-shaped pressure curve. With tire pressure of 35 lb. per sq.in., the subgrade pressure ranged from 20 to 24 lb. per sq.in. under the 4-in. roadbed, from 10 to 14 lb. under 8-in. roadbed, and from 4.5 to 6 lb. under 12-in. roadbed.

Conclusions: the shearing angle which defines the boundaries of the pressure-transmission cone is variable, becoming flatter with thicker roadbed; crushed rock distributes the load somewhat better than glacial gravel; and stabilization of crushed rock roadbeds with clay and emulsified asphalt increases the shearing angle with thin roadbeds, but not materially with thick roadbeds.—PROF. G. E. HAWTHORN, *University of Washington, Seattle.*

Road construction standards

On a traffic basis highways may be grouped in three classes. Class A highways are those used by more than 3,500 vehicles per day; class B, those of 900 to 3,500 per day, and class C, those of 250 to 900 vehicles per day. A safety survey of 24 states showed that class A roads have shoulders 2- to 7 ft. wide; class B roads, 2- to 6-ft. shoulders; and class C roads, 2- to 4-ft. shoulders. Maximum grades are: class A, 6 per cent; class B, 7 per cent; class C, 8½ per cent. Maximum curvature is: class A, 4 deg.; class B, 6½ deg.; class C, 13 deg. About half the states require spirals on curves; most of the states do not widen the roadway on curves and put no superelevation on spirals, but superelevate all curves exceeding 2 deg. Three-quarters of the reporting states stabilize the shoulders of class A roads with some form of bituminous material. The right-of-way width bought for new routes varies more than any other item discussed. The range on class A roads is from 60 to

400 ft., with a 100- to 200-ft. width predominating; on class B from 48 ft. up, usually between 60 and 120; on class C, 33 ft. up.—*Roadbuilders committee on alignment, grade and right-of-way.*

Ice control by abrasives

Highway safety depends as much on protection from icy pavement as on the elimination of any other hazard. The public is getting to the point where it justly demands treatment of all pavement in order to be protected against occasional patches of ice. With this requirement for treating the entire length of paved highway, stockpiles of abrasives are required and these must be kept from freezing. Early methods of applying chemicals to stockpiles and depending upon rain or snow water to dissolve them were highly unsatisfactory. A better plan, which reduced the chemical requirement by two-thirds, included advance treatment of the abrasives by chemicals in solution and then storing in stockpiles from which rain was excluded by the use of some inexpensive covering.

Methods and cost of ice control on highways vary widely: New York reported costs at $130 per mi. and in other states it ranged up to $300 per mi. per annum.—*A.R.B.A. committee on treatment of icy pavements.*

Sodium vapor lamps favored

The value of adequate street and highway lighting was emphasized by experience at Seattle, Wash., where 70 per cent of motor vehicle fatalities were pedestrians and 60 per cent of the accidents occurred at night until the installation of sodium vapor lights at danger points caused a sharp decrease in night accident rates. Trial installations of these non-glare lights, in various cities and at danger points on highways, were reported by several states, spurred on by a rapidly mounting rate of night accidents even where day accident rates have been materially decreasing. It is important to have a competent illuminating engineer work with the traffic engineer. —*A.R.B.A., committee report.*

For simpler specifications

Early form of specifications covered much in a few pages and left important decisions to the engineer and to the contractor. In contrast, present-day practice involves great detail and precise definitions that restrict and limit construction operations. Perhaps the time has come to start a swing back toward the earlier and simpler forms; somewhere between the two extremes lies a happy medium that would be more effective for all concerned.—FLOYD BOOE, *secretary-manager, Northern California Chapter, A. G. C.*

Kern county road planning

Kern County has been doing a job of preventive planning and adopting regulations and procedures for the protection of the margins of the Golden State Highway, U.S. 99, the main through-traffic route of the San Joaquin valley. Permits are required for approximately 70 mi. of its entire length in the county, requiring 30-ft. setbacks from the present rights-of-way, which are 115½ ft. in width. Architectural control is provided and restriction occurs in some areas. Billboards are only allowed on places of business and must advertise the establishment on which they are located. —STANLEY ABEL, *Taft, Calif.*

Western Road Reports

Contents in Brief *— The program of the Western Association of State Highway Officials at San Francisco last week included two sessions devoted to general discussions, of which those on road curves, soil studies and contract time limits are presented in abstract.*

Marking curves for safe speed

Wyoming is now posting safe speed in miles per hour on the sign which marks the start of each curve. Safe speeds for each curve were determined with an airplane bank-indicator and were selected as the speeds at which this indicator showed a 10-deg. deflection. This plan has been found particularly useful in Wyoming, which cannot afford as large a force of traffic patrolmen as is desired. Posting the safe speed has increased the average speed as well as the safety, because the driver knows just what he can safely do on each curve.—C. F. SEIFRIED, *office engineer, Wyoming highway department, Cheyenne.*

Contract time limit

In enforcing the time limit on a construction contract, the highway department determines each day on each contract whether it is a "working day" from the weather point of view. This avoids discussions and disagreements with the contractor; Colorado finds that dispute about weather is the source of most disagreements about contract time extension. Wyoming has greatly decreased overtime controversies by requiring the contractor to sign a weekly weather report made by the resident engineer. F. W. Panhorst, bridge engineer, California Division of Highways, stressed the value of careful advance determination of the proper time for each contract. Progress schedules based on the contractor's own estimate of time and statement of proposed methods are an aid in keeping progress up to requirements and furnish a basis for fair settlement when the reasonableness of the specified time limit is in question.—*Round-table discussion.*

Soil studies

E. A. Willis, Washington, D. C., who has been conducting a seminar in California, on soil studies, outlined the results of investigations recently made for the Bureau of Public Roads at various points throughout the country where soil studies have been under way. Progress in this field has been such, he said, that highway construction involving difficult earth formations can now be undertaken with much more confidence than formerly.

Dr. L. I. Hewes suggested that some thought be given to the question of whether the optimum water content remains constant in a carefully compacted fill and pointed out the need for a more precise definition of "subgrade," particularly with respect to depth for bearing values and for soil stabilization purposes.—*Round-table discussion.*

What Research Tells Pavement Designers

Contents in Brief—Rules for designing concrete pavement drawn from current and past research findings and given by E. F. Kelley, chief, Division of Tests, U. S. Bureau of Public Roads, in a paper read before the American Concrete Institute.

FOR OVER a quarter of a century research has been accumulating facts leading up to a method of balanced design of concrete pavement. Bit by bit facts have been accumulated on static and impact load stresses, on stresses induced by temperature and moisture, on subgrade reactions and on a host of other stress elements involved in the complex structure of concrete pavement. Theoretical analyses have kept pace with the research findings but like them are scattered over many years and through many publications. In 1935 a summation of the available information, and more particularly of the results of the extensive experiments of the U. S. Bureau of Public Roads, was given by L. W. Teller and E. C. Sutherland, engineers of the bureau, in *Public Roads*, the bureau publication.

The paper from which the conclusions here given are taken is a more recently digested summary of accumulated information; it brings together in one place and makes "available for the practical use of the designing engineer the important facts that have been developed thus far in research work relating to the structural design of concrete pavements." Given here are only the conclusions from the authors' voluminous presentation of records and analyses. They suggest striking changes in design practice, and are as follows:

Fourteen points of design

1. The critical load stresses developed in a concrete pavement are primarily dependent on single wheel loads and not on axle loads, axle spacing or the gross weight of vehicle.

2. Impact forces considerably in excess of static wheel loads should be used in the design of pavements. The impact factor (ratio of total impact reaction to static wheel load) is less for balloon tires than for high-pressure tires and decreases as the wheel load increases.

3. The stresses in a concrete pavement are about the same for an 8,000-lb. wheel load on dual high-pressure tires and for a 9,000-lb. wheel load on dual balloon tires.

4. The stress analyses of Westergaard, with the modification suggested by the Arlington tests, are suitable for use in the design of concrete pavement slabs and form the only adequate basis for such design.

5. Since the physical characteristics of the subgrade and of the concrete can never be foretold with certainty it is desirable to be conservative in the selection of values representing these various characteristics for use in design.

6. Warping stresses due to differentials of temperature within the slab may be of the same order of magnitude as the stresses due to heavy wheel loads and therefore require consideration in pavement design.

7. Reasonable assurance of the absence of transverse cracking in concrete pavements can be obtained only by the use of slabs that are about square with dimensions of the order of 10 ft.

8. Transverse cracks in thickened-edge pavements without reinforcement create a weakened condition in the interior of the slab which may be serious. The introduction of properly designed steel reinforcement in long slabs will not completely eliminate the detrimental effect of the cracks which may develop.

9. The edges of transverse joints in thickened-edge slabs require strengthening if the thickness of the free edge of the slab bears the proper relation to the interior thickness.

10. When the pavement is designed for maximum legal wheel loads and in such manner that the combined stresses due to load and temperature are limited to safe values and are reasonably well balanced, the thickened-edge section has no particular advantage over the section of uniform thickness from the standpoint of over-all cost per mile. The slab of uniform thickness has the advantage that edge strengthening is not required at joints and that transverse cracks do not create edge weakness.

11. Transverse joints are required in concrete pavements to relieve warping stresses due to temperature and also to provide for longitudinal expansion and contraction. Longitudinal joints are required to prevent the longitudinal cracking that usually develops otherwise.

12. If proper attention is given to the design of both the slab and joint, the required edge strengthening at joints in thickened-edge slabs can be obtained with a number of the types of load-transfer devices in common use.

13. The thickened-end transverse expansion joint is indicated, both by tests and experience, to be a highly effective method of providing the edge strengthening that is required at transverse joints in thickened-edge slabs.

14. Longitudinal joints of the tongue-and-groove type appear to be considerably more effective than other types in common use in providing the strengthening that is required in the edges of the longitudinal joints of thickened-edge slabs.

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Rochester Uses Radio To Inform the Public

Rochester, N. Y. citizens are getting better acquainted with local government affairs through a new weekly radio program, "A Day at City Hall," reports the International City Managers' Association. The weekly 15-minute broadcasts from a local radio station are arranged to come directly from the city hall desks of officials. They are informal, with various officials answering questions frequently asked by citizens.

At the end of the year City Manager Harold W. Baker made his annual report to citizens for the first time via the air. Listeners during a recent blizzard heard how city maintenance gangs were handling the snow removal.

As Others See Us

CLIFFORD MOSIER

Editorial Staff, *The Charleston Gazette*
Charleston, W. Va.

Contents in Brief *— A newspaper man turns a critical eye on the engineer and public works administrator and says, "Public relations counsel and application are just as important to you as are your technical qualifications for the job you hold." Then he gives a dozen or more reasons to prove his point.*

PERHAPS publicity counsel, with genius for catch phrases, can devise a better slogan for its own advancement, but the lawyers' old saw, "A man who acts as his own attorney has a fool for a client", will do until a better one comes along.

It is a notable truth in all exploitation that ideas must be "sold" into general use. Inventions rust in dark corners until salesmen seize upon them. Still remarkable, however, is the failure of the run-of-mine public, professional, business and industrial executives to use publicity in achieving their ends.

For example: Mayor A, seizing a chance to get PWA grants to finance badly needed improvements, blindly overlooked the possibilities of bond issues being blocked by a misinformed public. Although he had a city attorney and was a lawyer himself, he had no hesitancy in employing special counsel to handle legal details. And he retained a consulting engineer although he had a salaried city engineer at his disposal. But when it came to the public relations part of the job he held not the slightest doubt that he could handle this all by himself.

The PWA grant was made, but the city's matching funds were not found because the bond referendum miscarried. The grant fell through. Why? Because the publicity had been bungled.

Another case involves Engineer B. Under lay attack full of technical absurdities but plausibly concocted to defeat the project he was advising upon, he rushed into print with an ill-considered answer—factual but unconvincing—and ended by having to bow out of the deal as gracefully as principals could let him.

And then there is Architect D. He originally had been asked to design a building and his signature appeared on the first perspective drawing appearing in the press. Later this building collapsed with loss of life, injury, and property damage. An afternoon newspaper in hasty coverage found in its "morgue" clippings and cuts indicating Architect D as the designer, and coupled his name with the fault. Hitherto kept quiet had been the fact that Architect D, in conflict with promoters of the building who sought to revise his specifications to cheapen the structure, had privately withdrawn, and another architect had carried on to suit the promoters. Architect D, indignant, went to the morning paper with his complaint. They printed it, but inasmuch as their circulation was small and since they had a record of disputing every point the afternoon rival advanced, little attention was gained. The afternoon paper, faced with the facts but smarting at the architect's action, made legal retraction, but contrived it so that it was obscurely given.

Places for public relations

The writer could go on with examples of mishandled public relations. Not that a publicity man, or press agent, if you please, could have given 100 per cent cure any more than a lawyer can win all his cases; not that all men calling themselves public relations counsel deserve the title any more than all M.D.'s merit their degree. But wise men all over the nation are putting their best foot foremost by retaining specially talented, skilled and experienced men and women for indoctrination services. Both within and without the organization a clear and favorable picture must be limned and colored for success.

In justifying an idea, selling a project, bolstering a lost cause, gilding the lily and perfuming the rose of public character, the publicity man has a field all his own. He sparks ideas, finds holes through brick walls and is never without resources. He understands that language may expound or hide; that the arrow shot into the air may come to earth you know not where unless it is guided by intuition of where the target lies. He is a showman, an artist, a psychologist, and—above all— a realist.

Engineers are inarticulate

The engineer needs to do some thinking about public relations. As a class, engineers are probably the most inarticulate group of top-flight intelligents. They can translate algebraic formulas and logarithms into steel and concrete miracles. They can boss gangs of laborers speaking eighty different languages. They can talk to the leaders in other professions. But they rarely find words understandable to the man in the street, who votes and pays for and who is to use their products.

The engineer, in brief, seldom gets a good press.

This not only hurts a professional technician in his personal career, but also deprives a muddling public of badly needed guidance. Some cities have employed engineers as managers to advantage. The engineer's sanitation techniques are a necessity to medicine; his structures, to business; his city planning studies a step forward in sociology; his housing advances, transportation improvements, dams and bridges, power and fuel provisions, and a host of other considerations are of such benefit to the human race generally that his use as merely a tool for others is wasteful of talent.

At a recent regional meeting of the Am.Soc.C.E., a member complained of the sorry way politicians and public treat his profession. Engineers, he said, are generally called in like Peter the Great's technicians—just in time to hear the bad news; and like those builders, live only to hear the initiator get the credit for the planner-builder's work.

In this day and age, more than at any other time, public relations knowledge, including an appreciation of public relations counsel, is just as important to the engineer as are his technical qualifications for the job he holds.

Measuring Dam Behavior

DOUGLAS MCHENRY and ROY W. CARLSON
Massachusetts Institute of Technology, Cambridge, Mass.

Contents in Brief—Special instruments for measuring temperature, strains, joint openings, uplift, and even stress in concrete dams have been developed and promise to increase our knowledge and improve design. Results from instrument measurements at Norris Dam indicate that refinements in construction procedure will improve concrete gravity dams more than changes in design practice.

INTERNAL STRAINS and other conditions are being measured on a number of concrete dams because some degree of uncertainty in design assumptions is acknowledged. Some dams built a number of years ago, and believed when built to have been amply safe, have recently been ruled unsafe under full reservoir pressure. Still others may have margins of safety so high that if those margins had been known with assurance during the designing, economies would have been effected. The knowledge of behavior of a dam in service is, therefore, of value to that dam as well as to future dams.

The measurements that are made on a dam to determine the probable safety are necessarily varied. The mere magnitude of maximum strains and stresses is not sufficient, nor is it nearly as important as the *distribution* of stress and the change with time, because strength of concrete seldom governs the safety. The main factors governing the safety are (1) stability and uniformity of foundation, (2) amount and extent of uplift pressure, (3) occurrence of major cracks within the dam, and (4) relative thickness provided in design. Measurements are made in an attempt to evaluate any or all of these factors.

What is measured

Following is a list of the more common measurements attempted on dams, the reasons for making them, and the equipment commonly used:

(1) Temperature: because it is the main cause of cracking; measured by test set connected by 3-wire cable to electric resistance thermometers cast in the concrete,

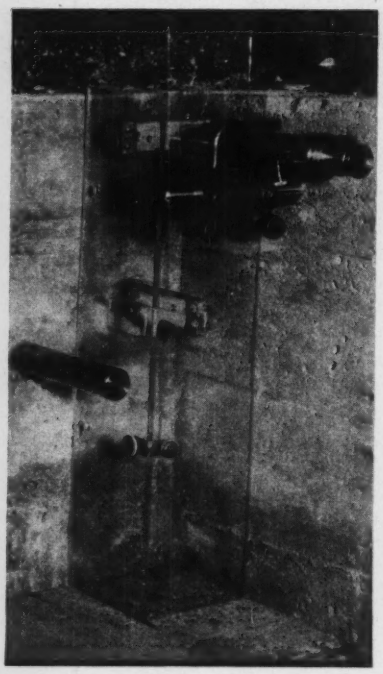


Fig. 1. Plumb line of stainless steel wire and microscope for measuring deflection of Norris Dam.

(2) Strain; because it reveals any large departure from designed behavior due to whatever cause and because it will reveal possible changes with time; measured by test set connected by 3-wire cable to electric strain meter cast in dam,

(3) Stress; because it reveals the exact manner in which the dam supports its load and therefore discloses the effect of uplift, cracks, etc.; measured by test set connected by 3-wire cable to electric "stress meter" cast into concrete. The stress meter is a diaphragm-like device, not yet described in literature, that detects compressive stress substantially independent of deformation of concrete,

(4) Joint opening; because it reveals the cumulative volume change of the concrete and because it controls grouting of contraction joints; measured by test set connected by 3-wire cable to electric joint meters cast across joint,

(5) Uplift pressure; because it has a decided effect on safety against overturning and sliding; measured by Bourdon gauge connected by pipe to pocket at point in question,

(6) Foundation deformation; because it reveals the adequacy of the foundation and possible yielding with time; measured either by means of electric meters grouted into drilled holes, or by special foundation meters applied to depths of 100 ft, or more, or by level measurements in galleries near base of dam,

(7) Horizontal deflection of dam; because it is a sensitive indication of the movement of the dam due to load, temperature, and possible foundation yielding; measured either by plumb wire and microscope, optical plumb line, or by theodolite sighting on target at crest of dam.

Instruments at Norris Dam

The program of experimental work at Norris Dam may be taken as typical of the investigations which have been undertaken at a number of concrete dams. The principal items of equipment at Norris consist of 29 uplift pressure cells on the foundation joint and 23 in the interior of the concrete, a plumb line and microscope for measuring deflection, 155 resistance thermometers, 72 elastic-wire strain meters, 49 joint meters, and three foundation deformation gages.

Uplift and deflection

Uplift measurements have shown that the design assumption of linear variation of uplift pressure from reservoir level at the heel to zero or tailwater level at the toe is sufficiently conservative. No information is furnished, however, to indicate the area over which this pressure acts. The measurements have also been valuable in indicating the area effectively drained by the relief holes, the proper depth of relief holes, and the rather remarkable reduction in uplift pressures which resulted from relief drilling near the downstream toe. Measurements for the past two years have shown that the pressures have followed the reservoir levels but

otherwise have changed only slightly with time, indicating the continued effectiveness of the relief holes.

The deflection measurements indicate a high degree of rigidity of the Norris foundation, and show movements of the dam that are consistent with changes in temperature and load. At a location where the dam is approximately 260 ft. high a stainless steel wire $\frac{5}{64}$ in. in diameter supporting a 17-lb. weight is suspended in an 8-in. diameter shaft near the upstream face. Movement of the wire relative to fixed scales is measured in recesses constructed on the upstream sides of two galleries, one near the foundation and one 80 ft. above the foundation. Measurements are made with a filar micrometer to the nearest ten-thousandth of an inch. The arrangement of one of the measuring recesses is shown by Fig. 1.

Initial deflection measurements were made on March 11, 1936, before the first filling and when the reservoir was still at a low elevation. Since that time measurements have covered a rather wide range of reservoir conditions, but the variation in deflection due to load has been so small as to be almost obscured by the variation due to the annual temperature cycle. Norris Dam bears east and west, with the downstream slope facing south. Thus the variation in temperature of the downstream face is considerably greater than that of the upstream face, and the temperature difference deflects the dam upstream in the summer and downstream in the winter. The magnitude of the full annual cycle of temperature deflection is roughly equal to the magnitude of the load deflection for maximum reservoir elevation. The daily cycle of temperature deflection may also be readily observed, as is indicated by Fig. 2.

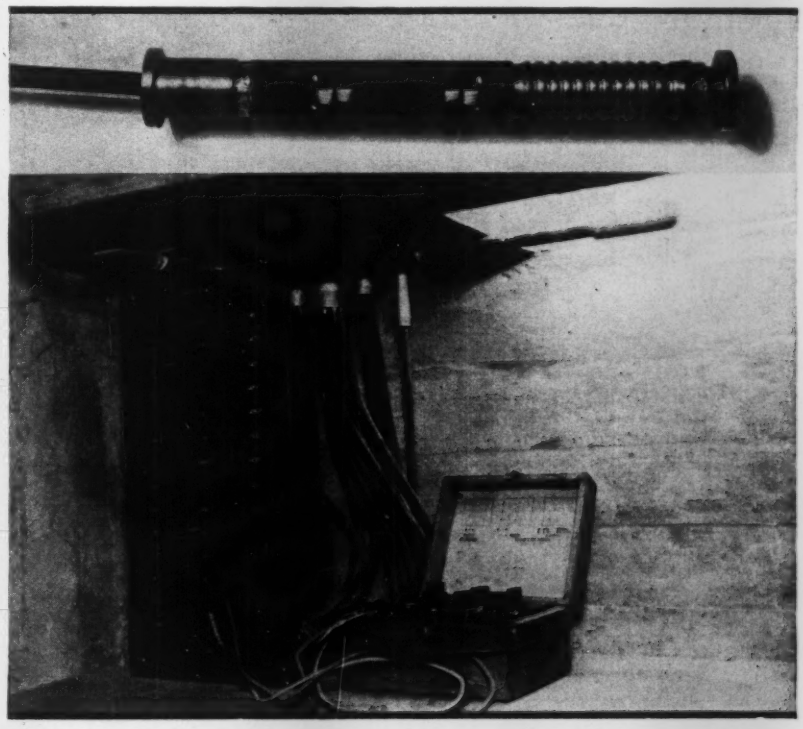


Fig. 3. Carlson elastic wire strain meter and terminal board recess in Norris Dam.

Strains in the interior of the Norris Dam were measured by elastic-wire strain meters of the type shown by Fig. 3. The least change in strain which may be observed by these instruments is about four millionths of an inch per in., corresponding to a stress variation of 6 to 16 lb. per sq. in., depending upon the age of the concrete and the duration of stress. All meters are installed in duplicate to minimize effects of inaccuracies of the measuring equipment and of lack of homogeneity of the concrete. At six locations near the foundation of the dam, strain meters were installed in groups of 12. Each group was designed to measure strain in four directions in a vertical plane normal to the axis of the dam, and also in the horizontal direction parallel to the axis. The remaining two meters were embedded in specimens of concrete placed at each of these locations in cavities within the dam so as to be stress free.

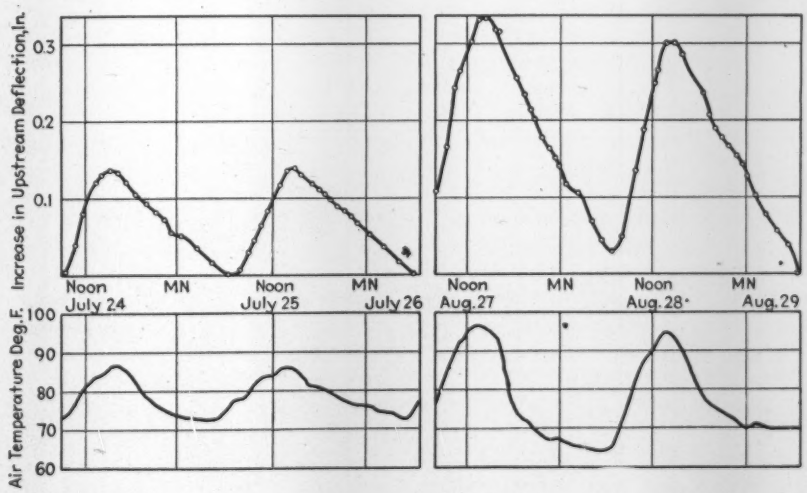


Fig. 2. Daily variation in air temperature compared with daily cycle of deflection at Norris Dam.

A typical record of one pair of meters is shown by Fig. 4. The rather unusual temperature history at this location is due to a peculiarity in the construction schedule. The meters were covered to a depth of 10 ft. on Dec. 30, 1934, and further concrete placing at this location was then discontinued until the following June. This peculiarity in the schedule afforded a great advantage in the conversion of the measured strains

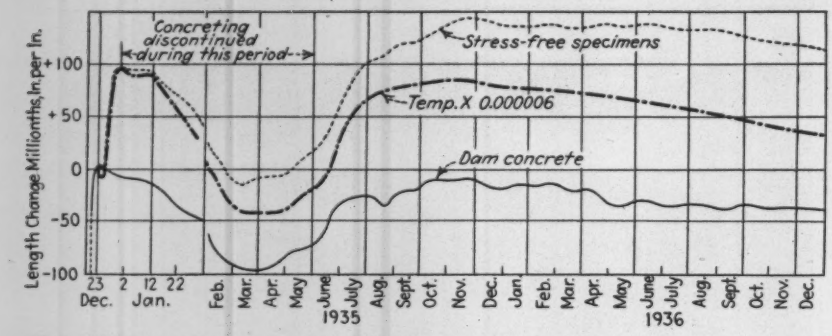


Fig. 4. Typical strain meter record. Difference between length changes in dam concrete and in stress-free specimen is the strain.

into stresses. Since the concrete in which the meters were embedded was over five months old at the time the load was applied, the complications introduced by the very erratic and almost unpredictable properties of concrete at early ages were avoided.

Although a complete study of the changes in strain indicated by Fig. 4 would require a large amount of data, which cannot be presented here, two points of rather general interest may be mentioned. The first is the excess in actual length change of the stress-free specimens over the length change computed from the temperature coefficient. This is in general agreement with laboratory tests which have indicated a growth of concrete under mass curing conditions when moisture loss is prevented. The second point concerns the behavior of the concrete during and immediately following the initial temperature rise. Free temperature expansion of the concrete in which these meters were embedded was prevented by proximity of the foundation rock and by the two adjoining blocks which had been poured previously. Under this condition it was expected that the initial temperature rise of the concrete would set up a compressive stress which would be gradually relieved by subsequent cooling and by plastic flow. It may be noted, however, that contraction of the meters starts as soon as the initial maximum temperature is passed, indicating that during the period of rapid temperature rise the concrete was so very plastic that little of the expected compressive stress developed. This conclusion appears to be rather general, and is confirmed by the joint meters. In nearly all cases the contraction joints started to open almost immediately after the maximum temperature had been passed. Similar results have been observed in recent laboratory tests elsewhere, in which concrete speciments have been subjected to just sufficient load to maintain them at a constant length while undergoing a mass temperature cycle.

Some conclusions

A few of the results of strain measurements in Norris Dam may be stated in general terms. The stresses obtained from the measurements appear to be fully accounted for by the weight of the dam and by changes in reservoir level and temperature. Although stresses due to temperature change are greater than those due to water load, such stresses do not tend to cause failure except as they may cause serious cracks. There is no indication of excessive uplift, foundation weakness, or dangerous cracks. The experimental work at Norris Dam is considered definitely valuable to the Tennessee Valley Authority, and similar work is being undertaken at Hiwassee Dam, which is now under construction.

It has been shown that minor refinements in the conventional design methods which determine the general shape and dimensions of a gravity dam have less effect upon stress distribution and safety than refinements in the construction procedure. This suggests that the construction program might well be considered as the governing element in the design of large gravity dams.

Engine Using Sludge Gas Fuel Gives Low Operating Cost

After 2½ years of highly satisfactory operation at Los Angeles, capacity of gas engine installation is doubled

ENCOURAGED by satisfactory operating experience over a 2½-yr. period with a 200-hp. gas engine in which the fuel consisted of sludge gas generated in an activated sludge sewage disposal plant, the Los Angeles County Sanitation Districts recently added a similar engine of 250-hp. capacity and now have entirely eliminated the use of commercial power at the plant. Detailed cost data on the original installation and estimated costs for the present enlarged installation are given in the following.

The original installation was a 6-cylinder, 200-hp. gas engine, direct-connected to an 18-in. centrifugal pump used for delivering effluent into the discharge channel. Other power requirements at the plant were met by electric motor installations operated with commercial power, thus affording opportunity for direct comparison of commercial power with that generated by sewage gas. (The combined installation of gas and electric power at the plant was about 1,400 hp.)

The initial 200-hp. installation was operated from May 4, 1935, to Oct. 14, 1937, with operating costs as itemized in Table I. When this installation was made, a contract was executed with the manufacturer's local representative for all engine maintenance and upkeep with the exception of ignition system and spark plugs. This contract was to run for a period of 5 yr. and the rate was .03¢ per hp.-hr. Although no record has been kept by the sanitation districts, it is believed that the actual cost to the contractor for this up-

TABLE I — OPERATING COSTS ON 200-HP. GAS ENGINE MAY 4, 1935, TO OCT. 14, 1937.

1	2	3	4	5	6	7	8	9	10	11
Operating periods	Hp.-hr.	Oil purchased (gal.)	Cost of equivalent commercial power	Upkeep	Lubrication oil	Spark plugs, etc.	Total maintenance and operation	Interest and deposits	M. & O. and interest and deposits (8 & 9)	Saving (4 − 10)
May 4, 1935 to December, 1935.	979,623	318	$5,172.41	$293.89	$184.50	$101.59	$579.98	$234.93	$814.91	$4,357.50
to December, 1936.....	1,636,761	477	8,642.10	491.03	277.65	27.00	795.68	352.40	1,148.08	7,494.02
to October 14, 1937.....	1,290,070	636	6,811.57	387.02	393.92	31.76	812.70	278.98	1,091.68	5,719.89
Total.....	3,906,454	1,431	$20,626.08	$1,171.94	$856.07	$160.35	$2,188.36	$866.31	$3,054.67	$17,571.41

Explanation of items:
Col. 4 — .65c. per kw.-hr. on switchboard.
" 5 — Maintenance payments at .03c. per hp.-hr. (contract).
" 6 — Actual oil cost. 21.9c. per 1,000 hp.-hr. = 2,730 hp.-hr. per gal.
" 7 — Includes spare magneto and magneto repairs.
" 9 — Equal monthly payment to amortize first cost.

keep has not exceeded .01¢ per hp.-hr.

In analyzing the operating data it is to be remembered that the initial installation permitted operation of the engine on a high load factor but that it also replaced commercial energy of the lowest rate per kw.-hr. Interest is figured at 5 per cent. No allowance is made for attendants, other than the contracted upkeep, because the cost of this item would be about the same for either electric or gas power.

The 200-hp. engine in the initial installation is of the vertical, 6-in.-line type with L-head design and valves on one side operated by a common camshaft. The cylinders are 9-in. bore and 11-in. stroke with a compression ratio of 5.85:1 giving a pressure of 135 lb. per sq.in. Forced-feed lubrication is used. Spark plugs are of the self-cleansing type. The speed is 550 r.p.m. under full load which calls for about 24 cu.ft. of gas per hp.-hr.

With completion of the White's Point ocean outfall in 1937, the entire method of operation at the plant was changed and instead of the 1,400 hp. previously used, less than 200 hp. will henceforth be sufficient for operating the plant as a sedimentation unit. However, for dependable operation some arrangement for standby power is considered necessary. With the 2½-yr. operating period to establish confidence, there was no hesitation in putting in another gas engine.

The new unit is similar to the one just described except that it is rated at 250 hp. and has 8 cylinders of the same size. For the present installation with two engines, each direct-connected to a generator, a separate power-house structure was required. This is in contrast with the initial installation which used space already available and operated on a high load factor without standby unit. The accompanying tabulations of costs have been compiled in such a way as to give what is believed to be a fair basis for comparison.

By reason of the very good operating record and the very clean condition of cylinder heads and pistons after long and continuous operation, it was not felt necessary in the new installation to protect the sanitation districts under a maintenance and upkeep contract with the manufacturers, the Clark Engine Co.

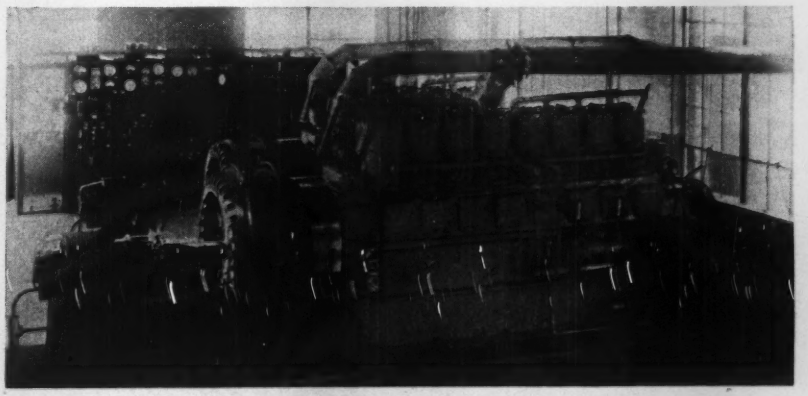
The plant is operated by the Los Angeles County Sanitation Districts, A. K. Warren, chief engineer and general manager.

TABLE II — ESTIMATED POWER COST WITH PRESENT GAS ENGINE INSTALLATION

Power equipment	Engine	Generator	Total
Unit No. 1 (200 hp.)	$5,867.00	$2,333.11	$8,200.11
Unit No. 2 (250 hp.)	8,723.55	3,415.00	12,138.55
Total	$14,590.55	$5,748.11	$20,338.66
Switchboard	.....	2,478.00	.....
Cooling system	1,333.00	.....	.....
Total	$15,923.55	$8,228.11	.....
Life — years	15	20	.....
Monthly amortization cost	$125.92	$54.30	$180.22
Structure			
Building	$19,520.32	.....	.....
Life	30 yr.	.....	.....
Monthly amortization cost	$104.79	.....	$104.79
Total monthly carrying charge			$285.01

Maintenance and operation					
Oil consumption *	.75 gal. per 1,000 kw.-hr. at 64c. per gal. = .048c. per kw.-hr.				
Cooling water	.1375 cu.ft. per kw.-hr. = .0275c. per kw.-hr.				
Maintenance and upkeep †	.015c. per kw.-hr.				
Monthly production kw.-hr	50,000	60,000	70,000	80,000	90,000
Maintenance at .00015	$7.50	$9.00	$10.50	$12.00	$13.50
Oil	24.00	28.80	33.60	38.40	43.20
Cooling water	13.75	16.50	19.25	22.00	24.75
Electrical maintenance †	2.50	2.50	2.50	2.50	2.50
Interest and depreciation	285.01	285.01	285.01	285.01	285.01
Total monthly cost ($)	332.76	341.81	350.86	359.91	368.96
Cost of equivalent commercial power ($)	674.50	805.50	913.49	972.56	1,031.63
Saving ($)	341.74	463.69	562.63	612.65	662.67

* Based on 2-mo. run.
† Estimated.



New plant interior showing 6- and 8-cylinder direct-connected gas engine units.

A Simple Rod Sounding Outfit

Contents in Brief — Details of rod sounding tools and the exact procedure of rod driving and splicing, rarely published, are described from actual practice of the New Mexico state highway department bridge engineers.

EXPERTS in soil mechanics give the sounding rod contemptuous mention as a means of predetermining subsoil conditions in designing foundations. The criticisms that they make have force, but rod soundings are more commonly used and more often meet the limitations of cost and skill in foundation subsoil exploration than do devices acknowledged to be more scientific. And rod soundings do give useful information, as the testimony of E. B. Van de Greyn, bridge engineer of the New Mexico state highway department, is proof. He says:

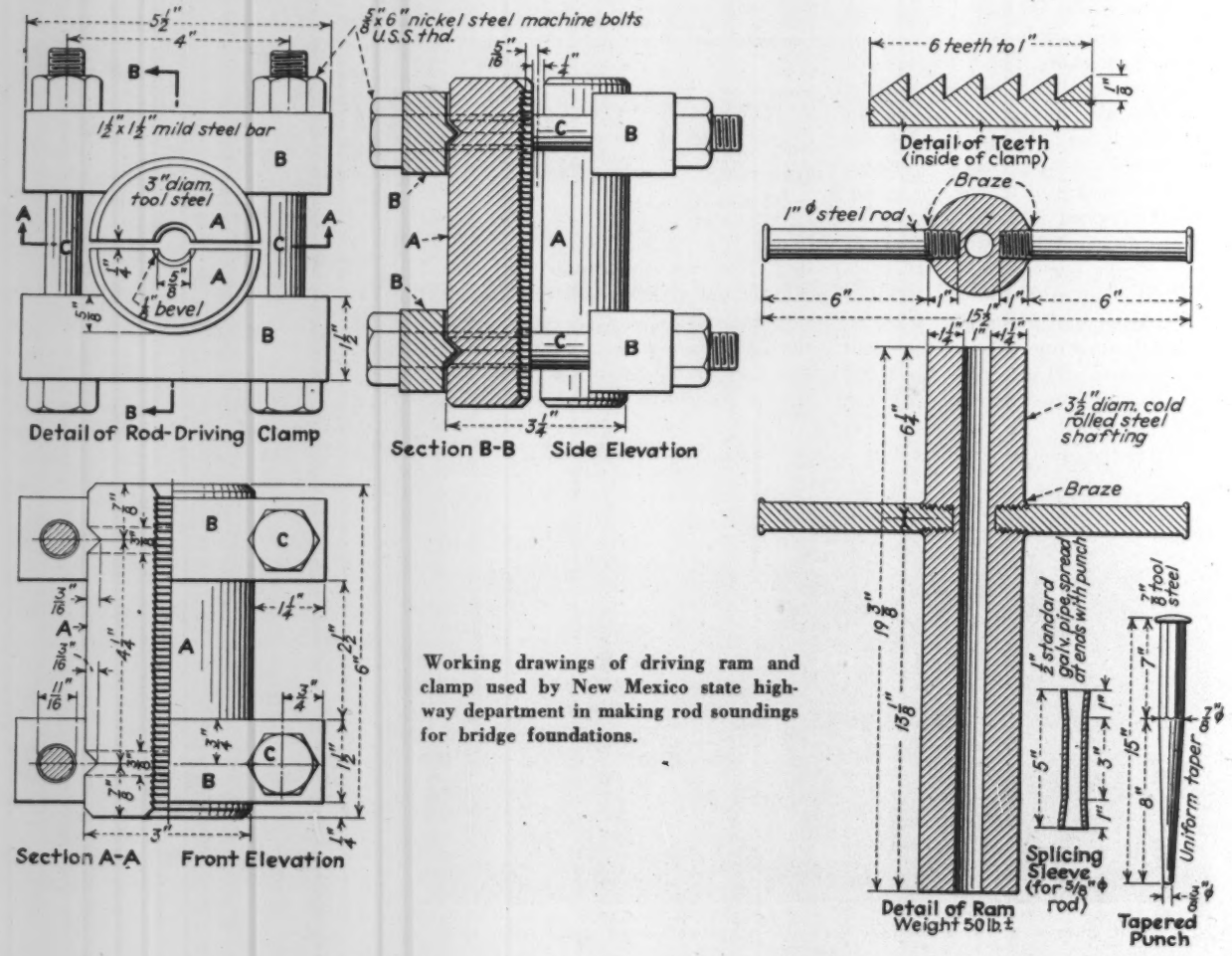
"We use rod soundings to a large extent to locate hard strata, sometimes before a pit is put down, to determine the length of sheathing required, and sometimes below the bottom of the dug pit for further data. Soundings are made to locate strata for judging the length of piles that can be driven and also to check strata between test pits. To facilitate rod sounding work, there is used the rod clamp and ram shown by the accompanying drawings."

The exact procedure in using the equipment, as described by Lee W. Campbell who designed the clamp and ram, is as follows:

1. The clamp is set on the ground at the point where it is desired to make the sounding, the bolts on the clamp being loose enough to allow a rod to slip through freely. The ram is then held on top of the clamp (with the holes in the clamp and ram vertically in line) and the rod is raised to a vertical position and dropped through the holes in the ram and clamp. The rod then may be pushed as far as possible into the ground by hand.

2. The clamp and ram are raised up the rod 2 or 3 ft. above the ground and the clamp bolts are drawn up as tight as possible. (It is important that the teeth in the clamp are pointed downward.)

3. The ram is then raised and dropped on the clamp, driving the rod. The rod itself acts as a guide causing the ram to strike the clamp squarely. (It is important for the purpose of record that the ram be



Working drawings of driving ram and clamp used by New Mexico state highway department in making rod soundings for bridge foundations.

dropped and the height of the drop recorded.) The driving continues until the clamp reaches the ground level. The clamp and ram are again raised to a point higher up the rod and the clamp fastened. The driving continues until the top of the first length of rod is about 18 in. from the ground level; the clamp and ram are then removed from the rod.

4. A piece of standard strength galvanized ½-in. pipe, 5 in. long, is used to make a splice when using a ⅝-in. rod. The tapered punch is driven into the pipe; then, using the ram as an anvil, the pipe is swelled on the end by hammering on the outside of the pipe to stretch the metal; then the punch is driven further into the pipe until the swelled end of the pipe will start over the top of the driven rod easily. (Care must be used to prevent splitting the pipe.) The pipe sleeve is then set on top of the driven rod and struck with a small hand hammer until it is securely fastened to the top of the driven rod.

It has been found that ⅝-in. rods are too light for driving in quicksand due to buckling when driven to any great depth, but ¾-in. rods spliced with pipe couplings have been driven to a penetration of 85 ft. The ¾-in. rods have the ends upset and are threaded with a ½-in. pipe thread. Heavy duty pipe couplings are used taking care to see that rods are screwed into the coupling so that the ends bear on each other.

5. The ram is slipped over the second length of rod while it is lying on the ground, then the clamp is slipped over the rod and bolted to it about 6 in. from the lower end. The second rod is raised to a vertical position (clamp and ram being at the lower end) and the lower end of the rod is set in the sleeve on the top of the driven rod. Then, driving is continued as described. (In cases of soft ground it is sometimes necessary to hold the bottom rod up with a wrench until sleeve and second rod are securely driven together.)

Rods are salvaged

In most cases it is possible to salvage the rods for re-use. This is accomplished by removing the clamp and placing it on the rod above the ram, then driving the rod back out by striking upward with the ram. It generally is not necessary to drive the rod back more than 2 or 3 ft. until it will become loose enough to be pulled out by hand. In most cases the sleeve will hold the bottom rods. When the sleeve reaches the ground surface the bottom rod is held with a wrench to prevent it from falling back into the hole and the sleeve is either cut off with a hack saw or knocked off with the hammer. As much as 60 ft. of rods have been pulled out and used over again, the sleeves having to be cut to get the rods apart. Another method sometimes used to pull the rod is to use a jack or a lever set against the bottom of the clamp. These devices will raise most of the rods easily. The rods are purchased in 20-ft. stock lengths and are used without cutting.

The notes of soundings taken with rods are so kept as to show the exact location of each sounding. The log of the driving is kept so as to show the average penetration per blow with the ram dropped from a given height. The size of the rods and the weight of the hammer used are also recorded with each set of notes. A small pickup truck is used to transport the equipment and the sounding crew.

An Analysis of Power Costs On an All-Electric Tunnel Job

IN PLANNING construction of the 11-mi. Stanislaus tunnel in California, the Pacific Gas and Electric Co. decided not to congest the limited transportation facilities with shipments of fuel, but instead to use electrical energy exclusively. Although the camps at the several tunnel adits are in a remote isolated region, a transmission line from a nearby power house passes close to them. Accordingly, electrical power is used for cooking, air and water heating, drying clothes in the change house, and other camp services, as well as for operating, practically all construction equipment. Thus the job affords an opportunity to obtain detailed costs on electrical power operation.

The accompanying table gives power consumption figures over a period of 13 months in camp and tunnel. The power rate used is the usual commercial rate less 10 per cent which is the company's basis for billing power supplied to its construction department. The notable differences between winter and summer power consumption in the camps arise from the wide temperature ranges that obtain where this work is under way.

Standard compressed air equipment is used in the tunnel for drilling, and compressors are driven by electric motors; storage battery locomotives are used for hauling in the tunnel, and all power-operated equipment is driven by electric motors. For the average heading advance of 1,329 ft. per month, energy consumption in the tunnel has been 136 kw.-hr. per ft. of tunnel at a cost of $1.10 per lin.-ft. Average cost per month for camp and cook house power is $633.52.

MONTHLY CONSUMPTION OF ELECTRICAL POWER ON THE STANISLAUS TUNNEL

Month	Feet of Tunnel	Total K.W.H.	K.W.H. per Ft. of Tunnel	Cost of Power for Tunnel Driving*	Cost of Power, Ft. of Tunnel	Camp & Cook House K.W.H.	Cost of Camp and Cookhouse Power*
Jan. 1937	468.8	62,500	133	$540.44	$1.15	140,000	$1,211.14
Feb.	514.2	102,770	200	867.94	1.69	110,230	930.99
March	1,143.5	153,600	134	1,172.30	1.02	108,900	831.00
April	1,546.5	188,620	122	1,527.01	.99	81,380	659.10
May	1,594.5	193,640	121	1,523.42	.96	46,360	364.73
June	1,771.7	219,900	124	1,731.95	.98	39,600	311.90
July	1,627.7	223,030	137	1,945.20	1.20	37,470	277.00
Aug.	1,919.1	241,970	126	1,937.35	1.01	34,030	272.60
Sept.	1,975.8	248,510	126	2,004.83	1.02	37,990	306.50
Oct.	1,963.2	252,450	129	1,943.38	.99	67,050	516.50
Nov.	1,106.6	180,390	163	1,515.50	1.37	95,610	803.80
Dec.	958.0	169,870	177	1,395.33	1.46	111,980	920.82
Jan. 1938	689.1	111,440	162	860.92	1.26	107,390	829.63
Total	17,278.7	2,348,690	.....	$18,966.07	.....	1,013,990	$8,235.71
Average per month	1,329.00	.....	136	1,459.00	$1.10	.....	633.52

* Cost of power is based on commercial rate less 10 per cent.

HYDRAULIC MODELS OF WELL-KNOWN STRUCTURES IN BUREAU OF RECLAMATION LABORATORY

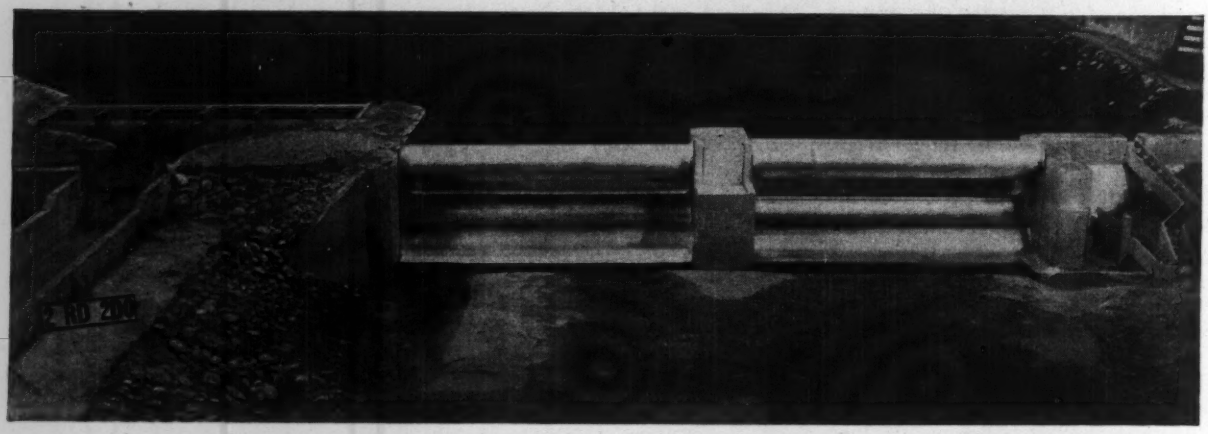


Fig. 1. A 1:48 model of Roza Diversion Dam on the Yakima River in Washington, used to improve the flow distribution in the canal intake, to reduce scour at the toe of the dam and to design the fish ladder at the right.

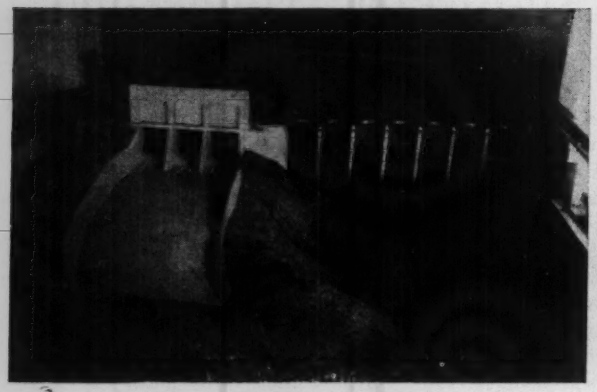


Fig. 2. Curved and superelevated spillway channel for Bartlett Dam near Phoenix, Ariz. This 1:100 model represents a 175,000 sec.ft. discharge capacity in the prototype.

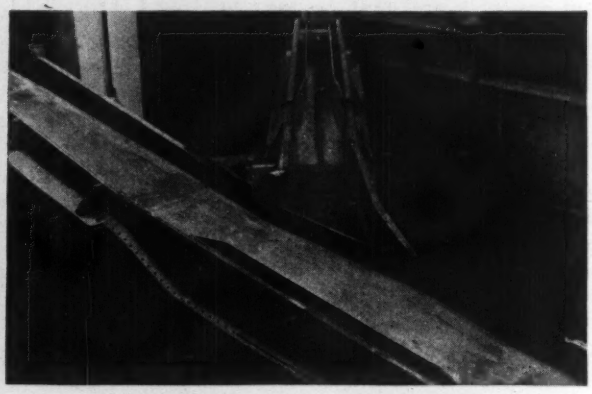
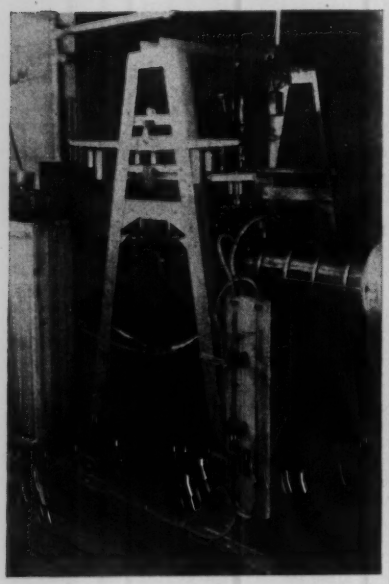


Fig. 3. Junction of outlet and spillway channels (1:60 scale) for Vallecito Dam near Durango, Colo. Weir dissipates outlet energy before water reaches spillway.



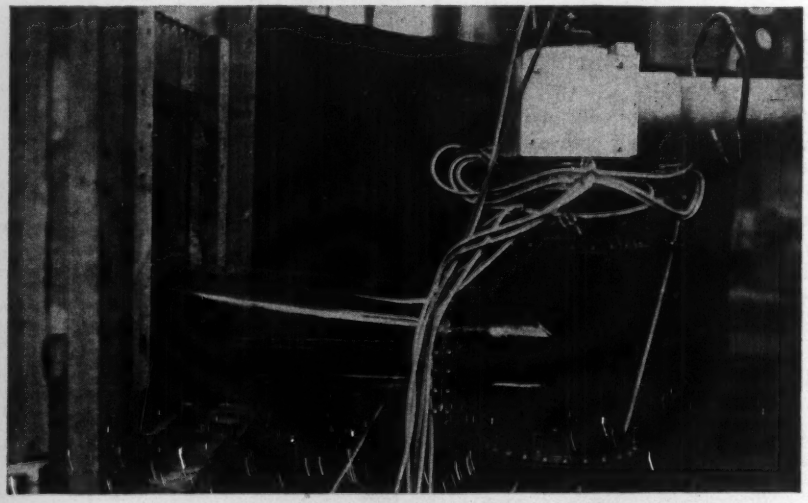


Fig. 4. Design and improvement of hydraulic equipment is aided by model study. At left is a model of one of the huge Grand Coulee turbines and at right a model for testing the Boulder Dam energy dissipators.

Research as a Design and Construction Tool

***Contents in Brief**—Research in the laboratory of the U. S. Bureau of Reclamation at Denver is of a type that is of interest to every engineer and construction man; for it is concerned with ways to design and build actual structures. This article tells what this great civil engineering laboratory does and reports some of its current work.*

IT ALL BEGAN with Boulder Dam. Too big to handle without new knowledge, and too urgent in point of construction time to permit the usual leisurely accumulation of this knowledge, this great project called forth a new technique—laboratory designing. In the end, Boulder Dam put the Bureau of Reclamation permanently in the research business. And the dividends paid the federal government in money saved, the profession in new knowledge gained and the users of the reclamation projects in increased safety and efficiency have been estimated to be worth many times the capital investment.

In ten years the research work of the bureau, begun somewhat as an emergency measure to see an unprecedented project through, has developed into a vital, routine design and construction tool. Today it continues to aid the Grand Coulees, the Shastas and the other great dams. But it does far more. It points the way to economies in all manner of small structures. It checks designs of canal drops, of stilling pools and fish ladders. It originates new cross-sections for spillways and chutes, aids the design of turbines, gates and pumps. It inaugurates testing apparatus and instruments and puts to practical use the wordy theories of the new science of soil mechanics. It devises better cements and paints, and it continually adds to the growing fund of knowledge that is slowly developing the durability potentialities of the material concrete. The story of research as it is practiced by the Bureau of Reclamation is presented here in pictures and text.

The laboratories of the bureau are divided into six major sections: Concrete and metals; cement and paint; hydraulic structures; hydraulic machinery; earth materials; and shops, where most of the test apparatus, models and equipment are made. They occupy about two-thirds of the basement floor space of the Customhouse, which covers an entire city block in Denver, Colo.

Hydraulics

During the past eight years the Bureau has been operating, intermittently, four hydraulic laboratories in which models of 100 hydraulic structures have been tested, representing both original and final designs. Coordination is maintained at all times between the design department, the laboratory, and the field. Models bring to light undesirable and unexpected flow conditions. They are extremely useful in developing needed alteration, indicate under or over design of structures, which often results in large economies in design, and make it possible to obtain values of various constants, coefficients and losses which have not been previously determined. Figs. 1, 2 and 3 illustrate some of the hydraulic problems adaptable to model study.

Pumps and turbines

The work of a group of hydraulic engineers in the hydraulic machinery section consists of research and model testing in connection with hydraulic turbines, pumps, gates and control machinery. Equipment comprises two 8-in. centrifugal units, a model of one of the Grand Coulee turbines, sluicegate models, gate and valve models, and various water-pressure measuring instruments.

The purpose of the Coulee turbine model, Fig. 4, is to aid in the design of a draft tube that will improve the efficiency of the units; and of a scroll case that will insure proper distribution of flow into the turbine runner. The effect on the runner of a vertical bend in the penstock immediately preceding the entrance to the scroll case was also a problem. The model will also be used to determine the effect of slide gates, butterfly valves or needle valves in the penstock preceding the scroll case entrance. Penstock, scroll case and draft tube are made of transparent pyralin.

The flow through each of the sixty

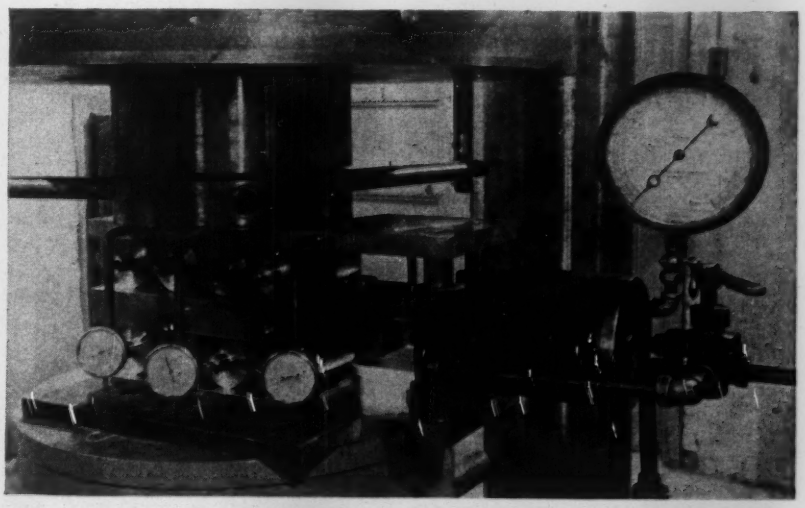
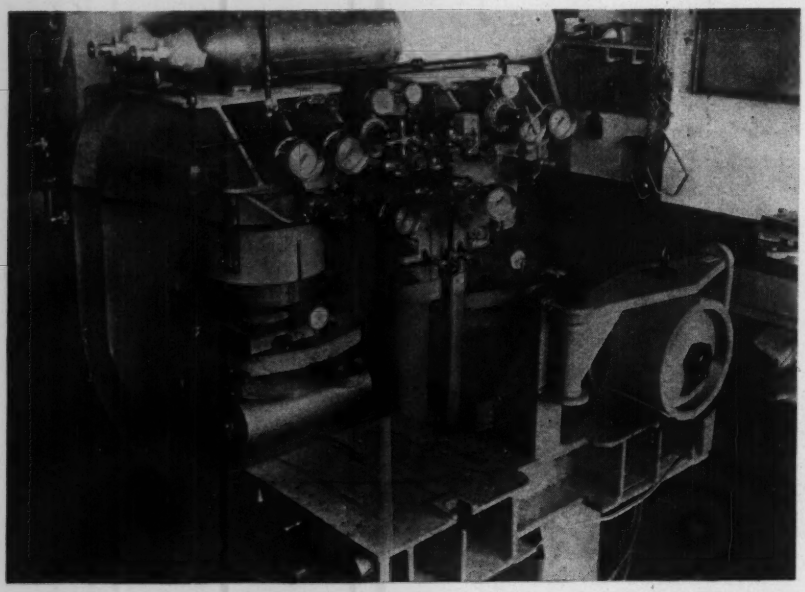


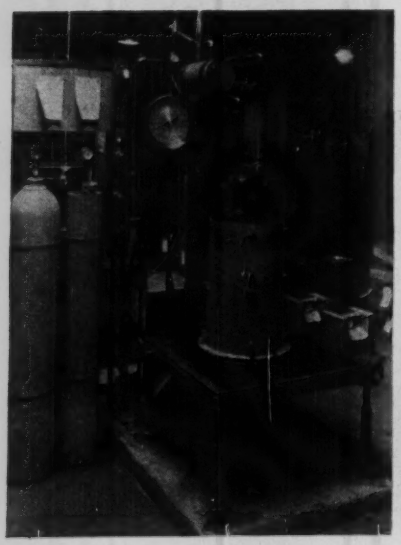
Fig. 5. Apparatus used in rolling friction test, made as part of design work on emergency gates for Boulder Dam.

8½-ft. Coulee sluice conduits is controlled by two 102-in. ring-seal ring-follower gates in tandem. Adverse cavitation experience elsewhere under lower heads led to experiments to reduce the pressure to atmospheric or above at all points inside the sluice entrance. The problem was one of determining the shape of a jet issuing from an orifice of this large size and then "tailoring" a bellmouth to fit it.

Pitting in needle valves due to retardation of flow near the nozzle is being studied by means of pyralin models to determine a correct shape of the various parts that will eliminate the unequal pressure areas.

Vibration in the Boulder Dam energy dissipators, installed prior to laboratory tests, was so excessive as to develop near-failures in some of the principal members of the unit. Transparent 1:12 models indicated extremely unstable flow and highly localized pressure, both conducive to vibration. Tests on a model with an altered design helped, but the trouble was almost entirely cured by a new and different design as determined by tests on the model shown in Fig. 4.





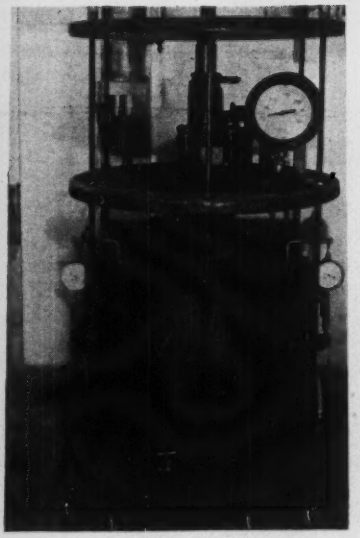


Fig. 6. Equipment for soils testing. Shear machine at top takes specimens as large as 1 sq.ft. and has a capacity of 30,000 lb. per sq.ft. for both shear and normal loads. Left, bottom is a pressure compaction machine which may be used to simulate action of a sheepfoot roller. In percolation cylinder at right, effect of stones up to 5 in. size can be studied.

The pumping plant at Grand Coulee Dam will be the largest of the kind ever built—twelve 1,600-sec.-ft. centrifugals discharging against 300-ft. head. The intakes will be 14 ft. and discharges 13 ft. in diameter. The fact that the pumps will be of the vertical, single-suction type with runners set 5 ft. below minimum pond level makes it necessary to put a vertical elbow in the suction pipe immediately below the pump inlet. The design of this elbow presents a problem of prime importance, as the performance and efficiency of the units will depend upon proper distribution of flow and pressures at the runner inlet. Models of the intake pipe are under test at the present time.

Metal Testing

Alloy steel, Monel metal and special alloy bronzes receive the attention of the bureau since they are widely used in gates, needle valves, grout stops and trash racks. Facilities include machines for routine testing of such properties as tension, compression, torsion, impact and hardness. Cameras record microscopic properties. Special tests are made on sliding friction, rolling friction and corrosion resistance.

As the emergency gates at Boulder Dam would have to operate under pressures that are excessive for sliding surfaces, rollers were proposed when the gates were being designed. Having no data available concerning the allowable loads and the coefficients of rolling resistance of small rollers on plates, when both rollers and plates are of high strength materials, laboratory tests were required. Fig. 5 shows a close-up of a test being made on this combination.

Trash-rack structures in the past have been made of mild steel, but extensive studies are now being made of the economy of using stainless steel. Corrosion is also being investigated in connection with stainless steels to ascertain their feasibility for use as grout stops in contraction joints of large dams.

Earth Material

The Denver laboratory makes the preliminary investigations on character and suitability of proposed embankment and foundation materials and serves as research laboratory in the field of soil testing. The general program on earth dams is one of cooperation between the investigation,

design, construction and materials testing sections.

In most cases, when preliminary investigations show a project to be feasible, a few miscellaneous samples from the foundation, excavation and borrow areas are submitted for general inspection and suitability tests. As the project reaches the design stage further investigation is made to aid a tentative plan for design and distribution of materials. Then, just prior to the beginning of construction, an earth-materials testing laboratory is established at the site. This procedure has led to simplification of control during construction, effected economy for both the bureau and the contractor, and at the same time has resulted in better earth dams.

The Denver laboratory is equipped to make all recognized tests in the field of soil mechanics. But, in addition to routine tests on properties of soils, many phases of research investigations have been carried on intermittently as time and facilities have permitted. Primarily these investigations have been along lines that would indicate the advantage of construction control of density and moisture; that is, how variations in density and moisture affect the three fundamental properties of the soil—permeability, consolidation and stability. Secondly, the investigations have been along lines directly affecting test procedure and the interpretation of test results, such as time of consolidation necessary for shear tests; comparisons of methods of compaction; effect of rock in a soil mass upon permeability, consolidation and shearing strength; and a study of internal pressures produced in specimens. The third general phase of investigations has been along the lines of chemical-physical and mineralogical properties of the soil.

Concrete Laboratory

The intelligent selection of the best aggregate feasible under the particular conditions attached to a given project and the specification of the selected material in the most advantageous way are the principal functions of this laboratory, whose studies conclude with a recommended mix for starting construction operations.

The laboratory has been instrumental in many studies of fundamental nature, such as the effects of size of cylinder, of size of aggregate, and of wet-screening upon various properties of concretes. Training for the task of concrete control has also been given to groups of field engineers. A concrete manual has been developed as an aid toward optimum uniformity throughout the bureau's concrete construction operations. At all times, the laboratory serves as a clearing house for information concerned with the latest developments in modern concrete practice.

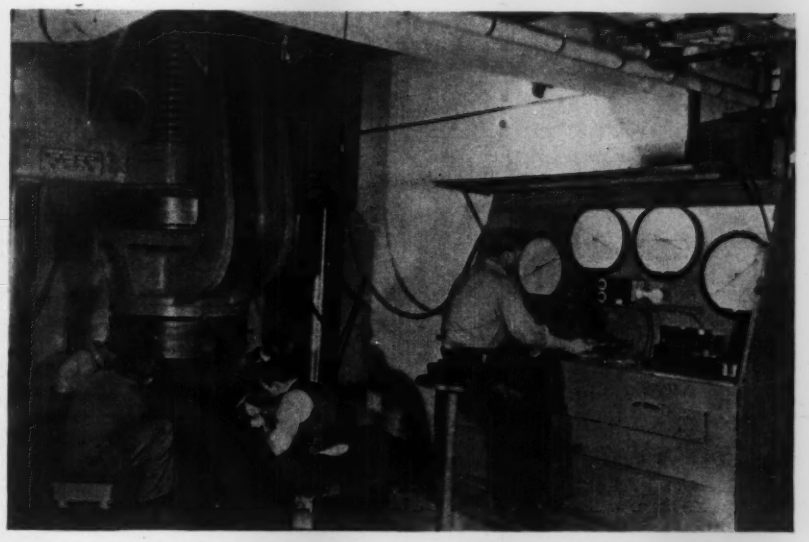


Fig. 7. Elasticity testing of 18 x 36-in. concrete cylinder in a 4,000,000-lb. testing machine.

Cement Laboratory

The cement laboratory investigates cement properties and their behavior in concretes to determine proper types for different construction purposes. High internal temperatures in massive construction require special cements. Cements resistant to the attack of alkali soils interest the bureau. Portland-puzzolan cements for mass construction have received intensive investigation. For all such work reproduction of job conditions is attempted. Cylinder test specimens up to 18 in. in diameter and 36 in. high, using 6-in. aggregate, with different cements, mixes and conditions of temperature and moisture simulating those within a massive dam have been tested.

Adiabatic calorimeter rooms are provided wherein the temperature is automatically controlled to agree within 0.1 deg. F. with that of hermetically sealed control specimens from the moment the specimens are cast. Fig. 8 shows the instruments controlling the heat supply, which is adjusted to agree with the concrete temperature throughout the test. As the concrete temperature rises the surrounding air in these rooms rises at the same rate. Other test specimens are cured alongside the control.

Expansion of concrete is studied in sulphate solution. Freezing and thawing tests are made in a cabinet containing calcium chloride brine into which concrete specimens, immersed in clean water within rubber receptacles, are lowered.

The resistance to cracking of mass concrete, containing different types of cements, has been investigated with the apparatus shown in Fig. 8. In this illustration (bottom right) hermetically sealed concrete cylinders are being held to constant length, representing the restrained state in the interior of a mass, while undergoing curing conditions equivalent to those in mass concrete. Such specimens first subject themselves to compressive stresses which later change to tensile stresses, finally resulting in failure. The relative abilities of concrete made with several cements to withstand this experiment have been correlated with the amount of cracking noted for them in mass concrete under actual service.

Thermal properties—specific heat and thermal conductivity—of concretes in proposed structures are determined in advance, to aid in the designs of cooling systems for the concrete, and in the selection of cements with suitable thermal characteristics.

The protection of ferrous metals, which are either continuously or in-

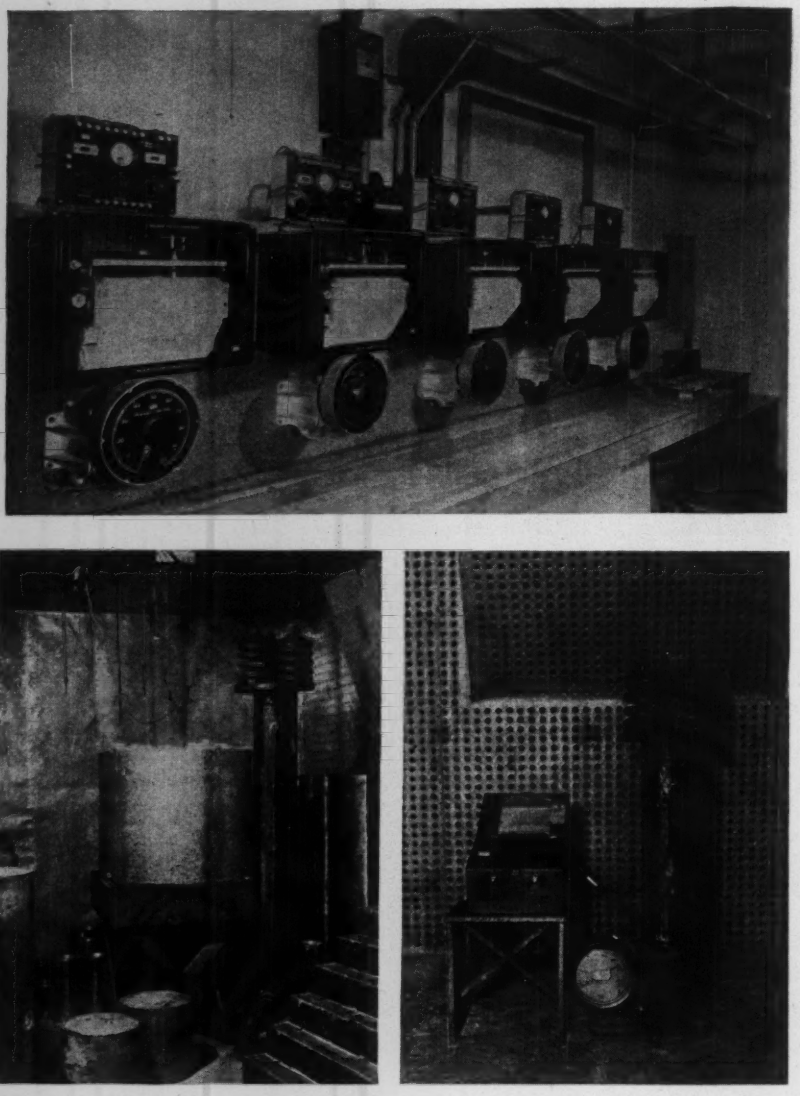


Fig. 8. Adiabatic curing of concrete. Top, temperature control instruments for adiabatic calorimeter room. Bottom left, interior of room and right a hermetically sealed specimen held at constant length during curing to determine cracking resistance.

termittently submerged in water or are otherwise subjected to corrosion, is the principal work of the paint laboratory. Other materials, allied to paint, that are studied include waterproofing agents, crack and joint fillers, and bituminous road and roofing materials.

The efficiency of membranous concrete-curing compounds is also determined by this laboratory. Such materials, offered by manufacturers, are investigated with performance-type tests to measure their moisture-retaining ability and relative merits. From these analyses and established properties specifications for these materials are drawn and instructions issued for their proper use.

All activities of the Bureau of Reclamation are supervised by John C. Page, commissioner, Washington, D. C., and all engineering and construction is under the direction of R. F. Walter, chief engineer, and S. O. Harper, assistant chief engineer, with headquarters in Denver, Colorado. Research and design work is directed by J. L. Savage chief designing engineer and W. H. Nalder, assistant chief designing engineer. The engineers directly responsible for the work in the Denver laboratories include Arthur Ruettgers and R. F. Blanks, who head the Materials Testing and Control Division of the Denver organization; J. E. Warnock, hydraulic structures; G. J. Hornsby, hydraulic machinery; E. N. Vidal, concrete and metals; H. S. Meissner, cement and paints; and L. W. Hamilton, earth materials.

• • •

Reservoir Lining Cracks Sealed with Bentonite

The concrete lining of the 3-m.g. reservoir on Yerba Buena Island in San Francisco Bay, which provides the water supply for the Golden Gate International Exposition, last year developed cracks sufficient to cause serious loss by seepage. These losses were greatly reduced (and showed no tendency to increase in the 7-mo. period from June to January) by the use of bentonite applied as described in the following.

The reservoir is an excavation on a steep side-hill whence Exposition needs can be served by gravity flow. After the excavation was finished the bottom of the reservoir (50x220 ft.) was covered with a 6-in. layer of concrete and the sides ($\frac{1}{2}$ to 1 slope) were lined with a 4-in. thickness of shotcrete around wire mesh.

After the reservoir was put in service, it was discovered that serious losses were occurring as the result of seepage. When the reservoir was unwatered for inspection no cracks were visible and it was concluded that leakage must be occurring through hair cracks in the concrete and shotcrete that opened under water pressure. It was therefore decided to try to stop the leaks with bentonite which could be applied while the reservoir was full. Accordingly, powdered bentonite (fineness to pass a 200-mesh screen) was mixed in 3-gal. batches, using $\frac{1}{8}$ lb. of bentonite per gal. These batches were applied through a 1-in. pipe put down into the reservoir through holes in the wooden roof. The pipe was put down to within a few inches of the bottom before the liquid was poured into the top of the pipe.

A total of about 100 lb. of bentonite was used in this treatment. Within three to four days after the treatment the loss by seepage had decreased from 9,000 gal. per day to about 2,000 gal. per day, which was considered satisfactory.

The treatment was devised by Charles H. Lee, chief, division of water supply and sanitation, Golden Gate International Exposition.

Exponential Formula Graphs

HAROLD K. PALMER
Santa Monica, Calif.

ENGINEERS USE many exponential formulas which involve three variables of the form $X = CY^mZ^n$. This can be represented by an alignment chart or by a group of straight lines drawn on logarithmic paper for a given value of C. The straight line graph, however, is much easier to make and use than the former. To make such a graph it is necessary to compute only two of the lines, which are parallel, and by means of an auxiliary or "interpolating" line, any others desired can be drawn without computation.

As an example a graph for the Scobey formula for flow in riveted pipe will be constructed. The formula is

$$Q = \frac{0.78\ H^{0.53}\ D^{2.58}}{K^{0.53}}$$

where

Q = flow in sec.-ft.
H = head loss in ft. per thousand
D = dia. of pipe in ft.
K = a constant depending on the roughness of the pipe

For $K = 0.32$

$$Q = 1.427\ H^{0.53}D^{2.58}$$

And for a given value of D this can be written

$$Q = CH^{0.53}$$

which can be drawn as a straight line with a slope of 1/0.53 on logarithmic paper. To prove the method, lines for three values of D will be drawn, although in practice only two are needed. Values of Q for two values of H and for three values of D are given in Table 1. The line on Fig. 1 to which they refer is also shown in this table.

TABLE I—NUMERICAL VALUES FOR CONSTRUCTING A GRAPH OF THE SCOBEY RIVETED PIPE FORMULA

D	$H = 1.0$ ft.	$H = 10.0$ ft.	Line on Fig. 1
1.....	1.427	4.84	*AA*
2.....	8.53	28.92	*BB*
5.....	90.74	307.61	*CC*

The three lines *AA*, *BB* and *CC*, corresponding to the three values of D are drawn through the six points on logarithmic paper. A straight line can be drawn through the intersections of the 1 ft. pipe line with the 1.0 ordinate, or value of H (point *a*), the 2 ft. pipe line with the 2.0 ordinate (point *b*) and the 5 ft. pipe line with the 5.0 ordinate (point *c*). This line is called the interpolating line because it locates the intersection of the line for any size pipe with its corresponding ordinate, through which a line is drawn parallel to *AA*.

Since pipe sizes are usually given in inches it will be easier to use a similar interpolating line for inch sizes. The 5-ft. pipe can be considered a 60-in. pipe, and the "inch interpolating" line can be drawn through the intersection of the 60-in. pipe line with the 6.0 ordinate (point *c'*) parallel to the original interpolating line. Then for a 40-in. pipe the pipe line is drawn through the intersection of the inch interpolating line with the 4.0 ordinate (point *d*), parallel to the other pipe lines and similarly for any other size desired.

This method of graphical representation is applicable to all exponential formulas. When considering flow of water in a pipe, for instance, it is often convenient to know the velocity (V) or the velocity head (H_v)

Since $Q = AV$

or $Q = A\sqrt{2gV^2/2g} = A\sqrt{2gH_v}$

Q can be computed for any given values of A and V or H_v. This has been done in Table II for 1 ft. and 5 ft. pipe for $H_v = 0.04$ ft., 0.10 ft. and 0.50 ft.

TABLE II—COMPUTED VALUES FOR A GRAPH OF THE FORMULA Q=AV

	1 ft. Pipe			5 ft. Pipe		
A.....	.785 Sq. Ft.			19.6 Sq. Ft.		
H_v.....	.04.	.10.	.50	.04.	.10.	.50
Q.....	1.3.	2.0.	4.5	31.5.	50.	111.2
Point.....	*J*	*K*	*L*	*J*	*K*	*L*

The three H_v lines drawn through these six points are found to be correct also for the 2 ft. and 40-in. pipe, and other H_v lines can be drawn by means of a corresponding interpolating line, *jl*.

The computations shown in Table 1 need not be made in this case because point *a* for the 1 ft. pipe can be located where $h = 1$ and $Q = 1.427D^{2.58}$, and through this point line *AA* can be drawn with a slope equal to the reciprocal of the exponent of H(1/.53 in this case) or $1/m$ in equation (1). To find this slope the two sides of the triangle must be measured in inches, disregarding the logarithmic lines.

The slope of the interpolating line will be $1/(n\text{-}m)$. Usually, however, it will be easier and more accurate to compute a second line like *CC* than to trust to a computed interpolating line.

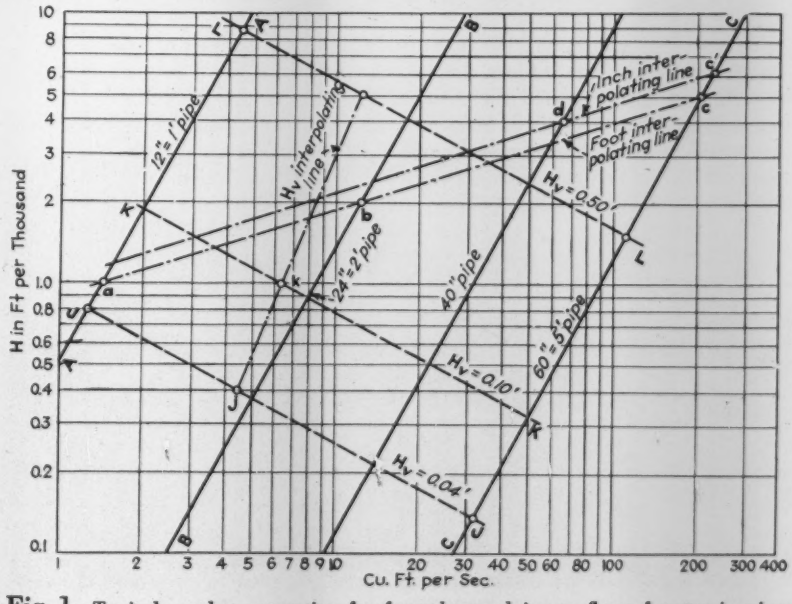


Fig. 1. Typical graph construction for formulas applying to flow of water in pipe.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Tower on Paving Mixer

RAY BLOOMBERG
Seattle, Wash.

In constructing 24 non-commissioned officers' quarters at Fort Lewis, near Tacoma, Wash., the contractor, Howard S. Wright & Co., Seattle, Wash., was confronted with the problem of designing a concrete-mixing plant that could readily be moved from one building to another and still have sufficient volume to maintain a definite construction schedule. The problem was solved by the use of a paving mixer, upon which a steel tower was built, accommodating a skip, a hopper and a chute; the 56-ft. spout was suspended to extend across the entire width of a building. This concrete outfit is moved under its own power from one building to the next with no loss of time and at a minimum cost of placing the concrete. Sand and gravel are batched and, except for the cement man, no labor is used until the concrete is deposited in the forms, where two electric vibrators are constantly at work. This equipment was designed by George Schuchart, president of the contracting firm.

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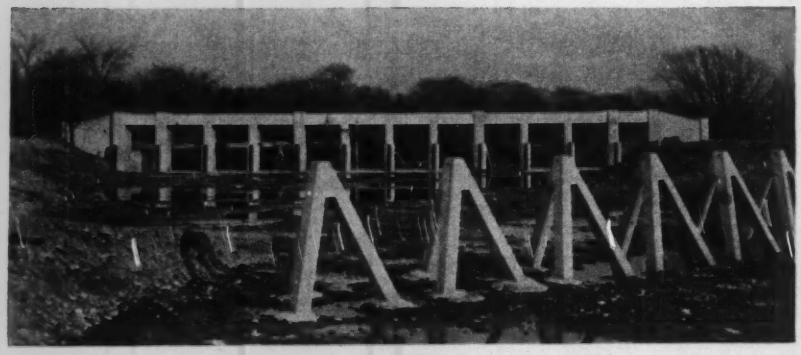
Ice Guards For Dam

Concrete tripods placed in a row in the Milwaukee River, at the Estabrook Park Dam, as shown, form an ice guard to prevent large blocks of ice from going through to the gates and to divert them to the spillway. This dam, at Milwaukee, Wis., is built in two sections, one being the gate section shown in the view, and the other the spillway section beyond the small island at the right of the gate section. At this point the river channel is 250 to 300 ft. wide, and in it is a curved weir having a total length of about 530 ft. Its purpose is to maintain the level of the river and it will affect this level for about 3 mi. upstream. In time of flood, however, it is desirable and necessary to lower the flood elevation, and this will be done by means of the gates. A long curved weir was used to form the pool in order to pass the maximum amount of water with a minimum rise of head. The work is being done for the Milwaukee County Regional Planning Department, under the direction of E. A. Howard, supervising engineer.



Concrete tripods divert ice to spillway of Milwaukee River dam.

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Better Plate Girder Method

P. E. TAYLOR
Cleveland, Ohio

Of the two methods of figuring plate girders, the moment of inertia method is accurate but long, and the flange area method is short but inaccurate. However, there is a method that is short and of an accuracy that approaches very closely to the moment of inertia method.

Let t = Thickness of web
h = Effective depth
d = Depth of web
p = Distance C.G. of flange to extreme fibre
A_g = Gross area of flange
A_n = Net area of flange

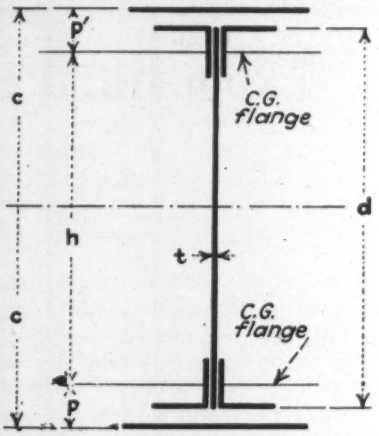

Diagram of symbols in plate-girder formulas

It will be necessary to make the following assumptions which are on the side of safety and are not very large: (1) Neglect I of the flanges about their own C.G.; (2) Let A_n or I_n of web = $\frac{3}{4}$ gross A or I, and (3) Assume $d = h$

We have the fundamental formula:

$$f = \frac{Mc}{I}$$

Then for tension flange

$$I_n = \tfrac{3}{4}\frac{th^3}{12} + 2A_n\left(\frac{h}{2}\right)^2 = \frac{th^3}{16} + \frac{A_n h^2}{2} = \frac{h^2}{2}\left(\frac{th}{8} + A_n\right)$$

But $\frac{th}{8}$ = $\frac{1}{2}$ web area

$$\therefore I_n = \frac{h^2}{2}\left(\tfrac{1}{2}\text{ web} + A_n\right)$$

Also $C = \frac{h}{2} + p = \frac{h + 2p}{2}$

$$f_t = \frac{M\left(\frac{h+2p}{2}\right)}{\frac{h^2}{2}\left(\frac{1}{2}\text{ web} + A_n\right)}$$

$$= \frac{M}{h} \times \frac{\left(1 + \frac{2p}{h}\right)}{\left(\frac{1}{2}\text{ web} + A_n\right)}$$

A similar method gives for the compression flange

$$f_c = \frac{M}{h} \times \frac{\left(1 + \frac{2p'}{h}\right)}{\left(\frac{1}{2}\text{ web} + A_g\right)}$$

It can be seen that these formulas are the usual flange area formulas multiplied by a factor

$$\left(1 + \frac{2p}{h}\right).$$

When designing new work the quantities p and p' are unknown. In this case it will be necessary to assume a value for p and use the formula:

$$A_n = \frac{M}{fh}\left(1 + \frac{2p}{h}\right) - 1/8 \text{ web area.}$$

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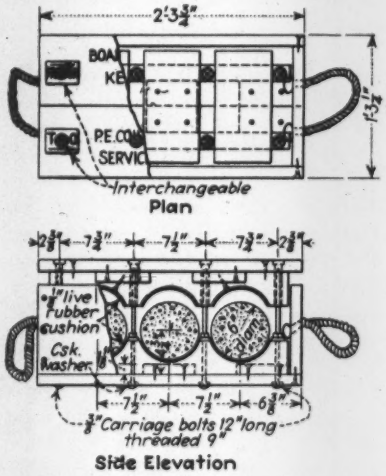
Box for Shipping Test Cylinders

To prevent breaking and chipping test cylinders of shaft-lining concrete, the engineers of the Rondout division of the Delaware River water supply aqueduct for New York City use the



shipping box shown by the above drawings. The box is made of white pine and weighs 43 lb. The cost of materials including paint is about $3.45.—*Delaware Water Supply News*, Board of Water Supply, New York, N. Y.

. . .

Heater for Winter Concrete Work

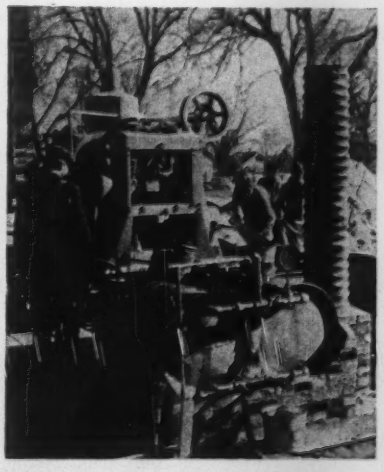
E. W. THORSON
Des Moines, Iowa

The very economical type of steam boiler illustrated is being used on the construction of two medium-sized architectural concrete jobs in Iowa this winter. Edward Dehnert, construction superintendent on a school addition at Luverne, and Charles Arquitt, construction superintendent on the municipal building at Farley, find them highly efficient.

Each boiler unit consists of two 55-gal. oil drums, laid side by side and hooked together with two pipes and a metal strap. The lower pipe keeps the water level in the two drums constant, while the upper pipe provides a steam take-off. The steam is piped to the concrete where perforations ($\frac{3}{16}$ in. at 12 in.) in the pipe laid on both sides of the wall allow the live steam to escape under the tarpaulins. Steam from the same source can be bubbled into the supply tank to heat the water for the mixer.

The cost of the two-drum heater with the necessary fittings will vary between $10 and $15 depending upon availability, while used pipe to be perforated and run alongside the forms (preferably 1¼ in.) can usually be purchased for about 5c. a foot.

Since high steam pressure is not necessary (4 or 5 lb. is plenty) the average oil drum is usually amply strong. A standard drum is equipped with two outlet plugs; a ⅝-in. plug in the head, and directly across, either in the head or side, another, usually 1¼-in. Each drum is laid with the ⅝-in. hole down and the 1¼-in. outlet at the top. To keep the water level constant in the two drums they are connected through the ⅝-in. holes and if water pressure is available a hose may be connected to this pipe with a T for refilling. Small petcocks are threaded into one of the drum heads ¼ and ½ of the distance down from the top, to be used in ascertaining the water level and holding it at the desired height. The two 1¼-in. outlets are then connected and the steam is taken off from a T on this connecting pipe. The blowoff or safety valve is also installed on this connecting pipe. This safety valve is absolutely necessary. In cold weather a low elbow may freeze the pipe shut and without a safety valve a great deal of damage might be done.



Job-made steam heater for winter concreting.

TRACTOR SNAG PULLER

Having long been used by loggers in the Pacific Northwest, the tractor and double-drum winch have now found new work in the flood-control program. This unit, an 81-hp. tractor equipped with a double-drum winch, is owned by the U. S. Engineer Corps, and is being used to remove snags and stumps from tributaries of the Mississippi River near Vicksburg. This is one of six units. The tractor is anchored securely on the stream bank and from it wire ropes are played out to stumps and brush in the stream. This brush is pulled in by the winch and is then skidded out of the highwater zone by the tractor.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Structural Design Aid

FORMULAS FOR STRESS AND STRAIN —By Raymond J. Roark. 326 pp. Published by McGraw-Hill Book Co., New York and London. Price $3.

New and more exact methods of stress analysis have multiplied rapidly in recent years, but they are scattered in numerous publications. Since this information is indispensable to the designer, a collection in one book of the formulas, facts and principles involved should prove decidedly useful. This book offers structural designers such a collection. It is a reference book on strength of materials and not a text. It does not include derivations of the methods, but it does illustrate their application. Photoelasticity, models, analogy methods, torsion, combined stress, buckling, dynamics, and temperature stresses are some of the subjects covered.

Municipal Public Works

THE MANAGEMENT OF MUNICIPAL PUBLIC WORKS—by Donald C. Stone. 344 pages. Published by Public Administration Service, 1313 E. 60th St., Chicago. Price. $3.75.

Effective management of municipal public works today calls for more than technical competency. And engineers who occupy administrative posts—or hope some day to qualify for positions of this type—must know and be able to apply certain principles of what industrial organizations term "scientific management." The science of industrial management is well established, of course, but relatively little has been accomplished in the formulation of similar principles for application in the field of public works administration. Perhaps the most active sponsor of development in this direction has been the Public Administration Service, which has engaged in the study and reorganization of public works departments in many municipalities. Drawing upon his experience and observation in this work, Donald C. Stone, executive director of the P.A.S., has written a practical handbook of management essentials. It is unique in that it deals exclusively with the problems and practices of public works administration.

Among the matters dealt with are: administration of personnel; work measurements and cost standards; planning and budgeting; cost accounting; purchasing; equipment management; engineering organizations; operation of utility services, and public relations. Adding to the usefulness of the book is the inclusion of some 70 forms which have been developed for keeping costs, performance data and other records of public works services.

Books on Highways

INTRODUCTION TO HIGHWAY ENGINEERING — Third Edition — By John H. Bateman. 442 pp. Published by John Wiley & Sons, New York; Chapman & Hall, London. Price $4.

Two successive editions of this book leave little to say beyond what was said in the first review (*ENR* May 19, 1928) and repeated in the second (*ENR* Aug. 26, 1934) namely, that it is one of the best textbooks on highway engineering that has been written. In this new edition the author has materially rearranged the order of presentation and added largely to the consideration of soils mechanics and of bituminous materials. The references for supplementary reading on these subjects are particularly valuable.

STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS and METHODS OF SAMPLING AND TESTING —Adopted by The Am. Assoc. of State Highway Officials. 383 pp. Published by the Association, 1220 National Press Building, Washington, D. C. Price $2.

Those familiar with the official character of the American Association of State Highway Officials need not be told of the high authority of its specifications and testing practices. This is the third edition of these standards for highway materials and contains all revisions up to October, 1938, and many new specifications and tests developed since the last preceding edition. The volume is the standard guide for all who furnish and use roadbuilding materials required by federal and state highway officials.

AMERICAN HIGHWAYS AND ROADSIDES—By Jac L. Gubbels. 94 pp. Published by Houghton Mifflin Co., Boston. Price $2.75.

Few activities of highway departments are less understood and less appreciated for their economic service than is highway landscaping. The common conception of the art is exemplified by the local garden club geranium bed, and if the book in hand did no more than to scotch this error, which it does excellently well, it would merit careful reading. Mr. Gubbels has not written a manual on planting or tree pruning; if these are all that highway engineers desire, he says, a gardener can do better than the landscape architect and at less cost. The landscape expert's duty is, beginning with location and design of the highway and working with the engineer, to add beauty to practicality, to increase safety and durability and to reduce operating cost. For those who want chapter titles, they are: the landscape engineer; location and alignment of the highway; the right-of-way; special engineering structures; care of trees and shrubbery; and plant life on the highway. Julian Montgomery, Texas state highway engineer, supplies an introduction that is well worth reading.

For Sanitary Engineers

COAGULATION AND SEDIMENTATION IN WATER AND SEWAGE TREATMENT—A bibliography—Prepared at New York University by U. S. Works Progress Administration. 236 pp. Paper cover. Limited free distribution.

A bibliography on coagulation and sedimentation in water and sewage treatment from 800 B.C. to 1937 A.D. has been compiled by WPA research workers under the direction of L. V. Carpenter, professor of sanitary engineering, New York University. Containing 2,154 references to books and articles in periodicals published both here and abroad, it has been classified and indexed for quick reference under

(Continued on page 78)

"If we stood upright like
we should
As Cutler-Hammer's do
This bum could find no
place to squat
And we'd work better TOO."

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NEW PUBLICATIONS

(*Continued from p. 72*)

several headings. This monograph, patterned after a similar bibliography on chloramine treatment in water and sewage practice recently made available is an invaluable source book of information for workers in the sanitary field.

CONCRETE PIPE IN AMERICAN SEWERAGE PRACTICE — Prepared and edited by M. W. Loving. 170 pp. Published by the American Concrete Pipe Association, 33 West Grand Ave., Chicago. Price on application.

Brought together in a compact volume is a wealth of information concerning the use, design and construction of concrete sewers. Special tables are provided for use in determining hydraulic properties, and there are chapters on general principles of sewer design and maintenance. A number of recent installations are described, and these coupled with liberal use of photographs provides an illustrated manual of modern construction methods. Also included are A.S.T.M. standard specifications for plain and reinforced concrete sewer pipe.

Mechanics Texts

MECHANICS FOR ENGINEERING STUDENTS—by John E. Younger, 461 pages. Published by International Textbook Co., Scranton, Pa. Price $3.50.

APPLIED MECHANICS—by Harvey F. Girvin. 336 pages. Published by International Textbook Co., Scranton, Pa. Price $3.

ENGINEERING MECHANICS—by Seibert Fairman and Chester S. Tutshall. Published by John Wiley & Sons, New York; Chapman & Hall, London. Price $2.75.

These three texts are all intended for use in mechanics courses for students who are already familiar with the calculus. Mr. Younger's book and the Fairman and Tutshall volume are designed to present only as much material as can be covered in a single course, while the Girvin book includes additional material. In particular, Mr. Girvin presents several chapters on graphical methods of solution which he suggests may be omitted if desired or used as the text for a course in graphical statics; he has also carried the work on loaded cables, plane motion, and impact somewhat farther than is customary.

Mr. Younger emphasizes d'Alembert's free-body method of solution throughout. The book is unusual in including some introductory vibration theory and in devoting a chapter to the method of dimension in the application of model tests. The Fairman and Tutshall text likewise introduces material on dimensional analysis and in the section on kinetics gives the dimensional formulas for each new quantity. Answers are given to all problems; neither of the other two books follows this practice

Surveying

ROUTE SURVEYS—By Harry Rubey. 288 pp. with 261 pp. of tables. Published by The Macmillan Company, New York. Price $3.75.

Following suggestions made at the 1937 Surveying Teachers Conference, Professor Rubey, who is chairman of the civil engineering department at the University of Missouri, has prepared a route construction handbook which can be used to teach a college course "with an engineering flavor rather than with a strictly surveying flavor." Following this policy, there have been added to the usual railroad curves and earthwork textbook material, chapters on rights-of-way, construction procedure and data, observations for meridian, adjustment of instruments, and arc definition of degree of curve.

REPORTS AND PAMPHLETS

MANSFIELD, MASS.—Annual Report of the Town Affairs, 1938.

WILMINGTON, DEL.—Annual Report and Statement, 1938.

SYRACUSE, N. Y.—Annual Report of the Department of Engineering.

CONNECTICUT, Hartford—Seventh Biennial Report of the State Water Commission (1936-38).

CALIFORNIA, Sacramento — Eleventh Biennial Report of the Division of Highways.

NEW YORK CITY—Ninth Annual Report of the Regional Plan Association.

WASHINGTON, D. C., Report of the Chief of Engineers, U. S. Army, 1938, Part. I, Vol. I.

UTAH, Salt Lake City—Twenty-First Biennial Report of the State Engineer.

IDAHO, Boise—Tenth Biennial Report of the State Department of Public Works, 1938.

PENNSYLVANIA, Harrisburg—Activities and Accomplishments of the General State Authority, 1935-38.

LONDON—Thirty-Second Annual Report of the Metropolitan Water Board, 1937.

OKLAHOMA, Oklahoma City—Report of the State Highway Commission, 1937-38.

MARYLAND, Baltimore—Report of State Planning Commission on Legislative Councils.

MARYLAND, Baltimore—Five Years of State Planning, a report by the Planning Commission, Dec. 1938.

NEW PUBLICATIONS

EARTHQUAKE HISTORY OF THE UNITED STATES—Part I, Continental United States, excluding California and Western Nevada; U. S. Coast & Geodetic Survey, Serial No. 609. 20c. from Supt. of Documents, Washington, D. C.

CITY PLANNING—WHY AND HOW—By Harold MacLean Lewis. 257 pp. Published by Longmans, Green and Co., New York. Price $2.50.

REPORT OF THE ROAD RESEARCH BOARD (year ending March 31, 1938) —191 pp. Prepared and published by the Dept. of Scientific and Industrial Research, London. Available at British Library of Information, 270 Madison Ave., New York. Price $1.20.

DER BETON—By Dr. Richard Grun. 498 pp. Published by Julius Springer, Berlin. Price RM 39.

ENGINEERING'S PART IN THE DEVELOPMENT OF CIVILIZATON—By Dugald C. Jackson. 114 pp. Published by The American Society of Mechanical Engineers. Price on application.

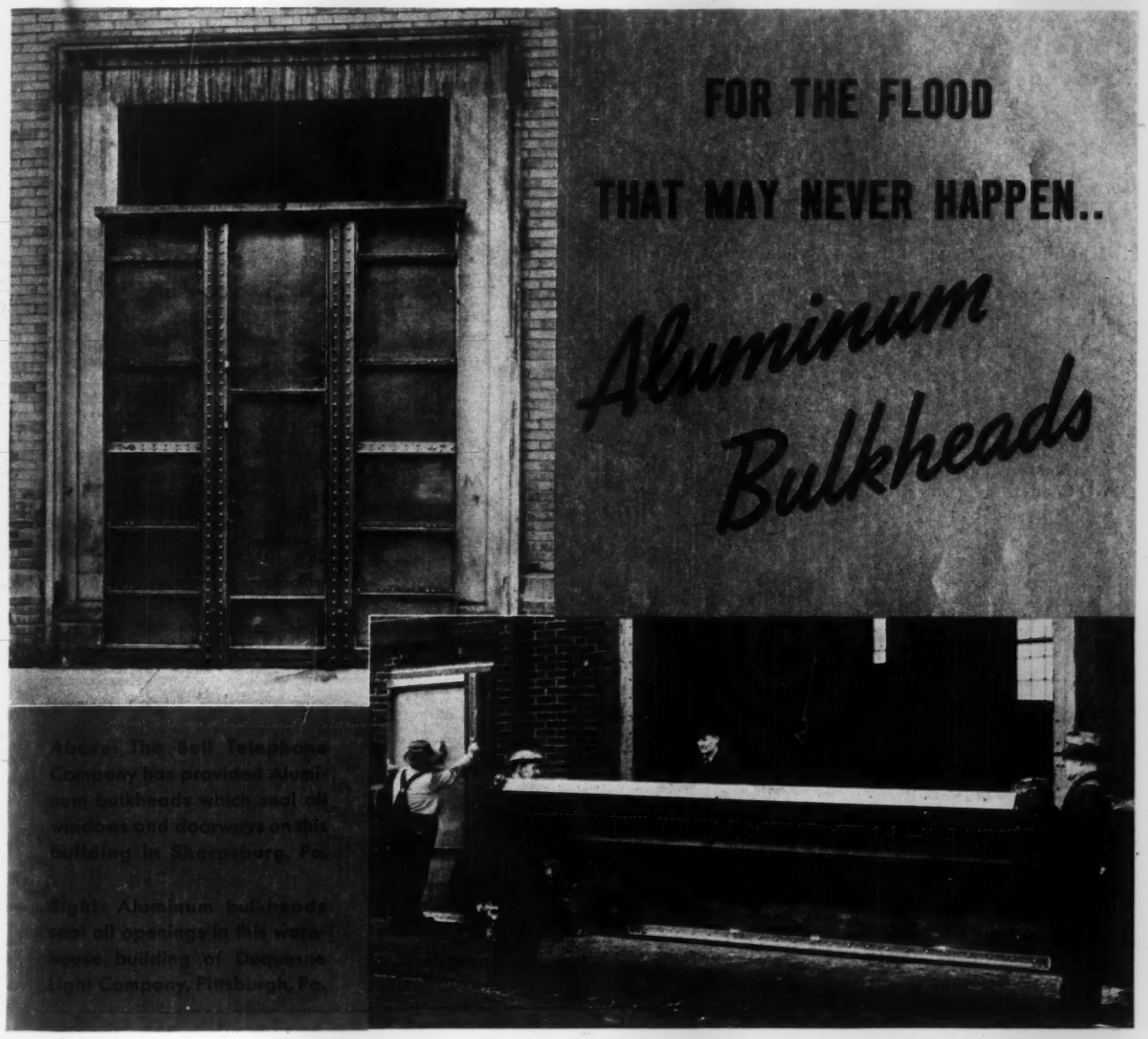
THE WORKER, THE FOREMAN AND THE WAGNER ACT—By Russell L. Greenman. 137 pp. Published by Harper & Brothers, New York. Price $1.50.

A SHORT HISTORY OF THE STEAM ENGINE—By H. W. Dickinson. 255 pp. Published by The Macmillan Co., New York; The University Press, Cambridge. Price $3.50.

HOUSE CONSTRUCTION DETAILS—By Nelson L. Burbank. 317 pp. Published by Simmons-Boardman Publishing Corp., New York. Price $3.

INDUSTRIAL ARCHITECTURE OF ALBERT KAHN, INC.—By George Nelson. 175 pp. Published by Architectural Book Publishing Co., Inc., New York. Price $6.

WASSERKRAFTANLAGEN: HANDBIBLIOTHEK FUR BAUINGENIEURE —By Adolf Ludin. 734 pp. Published by Julius Springer, Berlin. Price RM 78.



Above: The Bell Telephone Company has provided Aluminum bulkheads which seal all windows and doorways on this building in Shorpsburg, Pa.

Right: Aluminum bulkheads seal all openings in this warehouse building of Duquesne Light Company, Pittsburgh, Pa.

Pittsburgh may never have another flood. Yet many building owners are taking no chances. They have provided Aluminum Alloy bulkheads with which windows and doorways can be quickly and securely sealed should a flood threaten.

Aluminum bulkheads offer these advantages: Their light weight makes handling easy; they can be moved from storage and lifted into place with a minimum of labor. There's no warping or shrinking to destroy their usefulness, no rusting or rotting to require frequent painting to keep them serviceable. They will be ready in case of an emergency.

You may not have a flood hazard. But there must be many places where the light weight of Aluminum, its permanence and fine appearance will prove equally valuable to you. Ask our engineers for recommendations on Alloys of Alcoa Aluminum to meet any problems you may have. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WATER MAIN, OHIO

OWNER: City of Cincinnati; J. E. Root, City Hall, engineer.

PROJECT: Construction of Sunset Avenue feeder main from Queen City Ave. to Glenway Ave. of cast iron pipe with a minimum of 3½ ft. of cover. Transportation by rail and highway is available, and all pipe, valves and specials are furnished by the city.

BIDS: Six bids were received January 31, 1939, ranging from the contract low of $19,466 to $29,770.

LOW BIDDERS:

1. The White Construction Co., Cincinnati (contract) $19,466
2. O'Connell & Sweeney, Cincinnati..... 19,805
3. The Byrnes-Conway Co., Cincinnati..... 21,772

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Laying 6 in. C.I. pipe Cl. 4 pavement.	50 l. f.	$ .60	$1.50	$1.00
2. Laying 12 in. C.I. pipe Cl. 4 pavement.	50 l. f.	.80	2.00	1.50
3. Laying 16 in. C.I. pipe Cl. 1 pavement.	100 l. f.	4.00	4.00	3.50
4. Laying 16 in. C.I. pipe Cl. 4 pavement.	5,600 l. f.	1.50	2.10	3.50
5. Laying 16 in. C.I. pipe Cl. 6 pavement.	1,200 l. f.	2.50	2.20	3.50
6. Laying 24 in. C.I. pipe Cl. 1 pavement.	20 l. f.	4.00	5.00	4.50
7. Brickwork	50 c. y.	10.00	30.00	27.00
8. Concrete Cl. 1	200 c. y.	4.00	3.00	10.00
9. Concrete Cl. 2	25 c. y.	4.00	3.00	8.00
10. Concrete Cl. 3	50 c. y.	4.00	3.00	6.00
11. Hauling	575 tons	3.00	2.00	1.50
12. Removing mains	50 l. f.	.01	.10	.50
13. Additional excav.	500 c. y.	.01	.20	.01
14. Rock excav.	1,500 c. y.	2.70	.50	.01
15. Steel	4,000 lb.	.03	.04	.06
16. Changing 6 in. sewers	100 l. f.	.05	1.25	.50
17. Changing 8 in. sewers	50 l. f.	.05	.20	1.00
18. Changing 12 in. sewers	50 l. f.	.05	1.00	1.50
19. Changing 15 in. sewers	10 l. f.	.05	.50	2.00
20. Changing 18 in. sewers	50 l. f.	.05	.50	2.00
21. Changing 20 in. sewers	25 l. f.	.05	.50	2.00
22. Changing 24 in. sewers	25 l. f.	.05	.50	2.50

HIGHWAY BRIDGE, ARIZONA

OWNER: State Highway Commission, Phoenix; W. R. Hutchins, engineer.

PROJECT: Construction of a steel plate girder bridge on concrete pile foundations across the Little Colorado River, two miles east of Winslow on the Winslow-Holbrook Road, in Navajo County. The bridge will have nine spans and will be 801.5 ft. long. Stipulated contract time is 290 days. Transportation facilities by rail and highway are available.

BIDS: Seven bids were received February 7, 1939, ranging from the contract low of $130,289 to $151,896. Minimum wage rates are as follows: Skilled, $1.00 per hr.; semi-skilled, $0.6875 per hr.; common, $0.625 per hr.

LOW BIDDERS:

1. W. E. Bondurant, Roswell, New Mexico (contract) $130,289
2. Lee Moor Contr. Co., El Paso, Tex..... 135,074
3. M. M. Sundt Construction Co., Tucson, Ariz... 140,156

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Struct. excav. (Uncl.)	880 c. y.	$5.00	$3.00	$1.50
2. Cl. "A" conc	927 c. y.	19.00	20.00	20.00
3. Cl. "A" tremie placed conc	45 c. y.	15.00	14.50	30.00
4. Cl. "D" conc	655 c. y.	21.50	20.00	21.00
5. Reinf	188,178 lb.	.042	.045	.046
6. Struct. steel	746,555 lb.	.056	.06	.065
7. Conc. Piles	7,430 l. f.	2.90	2.80	3.08
8. Driving piles	164 ea.	20.00	36.00	23.00
9. Conc. test piles	145 l. f.	3.00	4.50	4.00
10. Driving test pile (55 ft. conc.)	1 ea.	100.00	120.00	175.00
11. Driving test pile (45 ft. conc.)	2 ea.	100.00	100.00	175.00
12. Loading tests	3 ea.	50.00	100.00	125.00
13. Steel sheet piling	8,420 l. f.	1.60	1.70	1.62
14. Driving piles (steel sheet)	248 ea.	8.00	7.00	9.00
15. Rock backfill	1,300 c. y.	2.00	2.10	3.00
16. Cartouches	4 ea.	10.00	120.00	25.00

SEWAGE WORKS, SOUTH DAKOTA

OWNER: City of Sturgis, S. D.; Chenoweth, Fraser and Forrette, Rapid City, engineers.

PROJECT: Construction of a sewage treatment works for a population of 6,700, and construction of 19,600 ft. of 10- and 12-in. sewer. Stipulated contract time is 250 calendar days. Transportation by rail and highway is available. The plant location is easily accessible and digging conditions are favorable. The sewer is located largely in open field and very little of it will require excavation of more than five feet. The job is split into three schedules. Schedule A is for the intercepting sewer; Schedule B is for the sewage treatment works; Schedule C is for an operator's dwelling house. Price data on the first two schedules are given.

BIDS: Bids were received February 24, 1939. On contract A, eight bids were received ranging from the contract low of $26,949 to $35,696. On contract B, six bids were received, ranging from the contract low of $42,537 to $52,900. As the low bidder for Schedule B stipulated that he would not accept Schedules A or B separately, the second low bidder for Schedule B received the award. Minimum labor rates are as follows: Skilled, $1.00 per hr.; semi-skilled, 66c. per hr.; common, 45c. per hr.

LOW BIDDERS (SCHEDULE A):

1. A. C. Smith, Scottsbluff, Neb. (contract).... $26,949
2. Bonesteel & Hyde, Watertown, S. D..... 28,859
3. Barnett & Record, Minneapolis..... 28,863

SCHEDULE "A"

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Wet excav.	100 c. y.	$2.50	$3.00	$3.00
2. Rock excav.	600 c. y.	3.00	2.00	5.00
3. Clay tile sewer 10 in.	6,739 ft.	0.60	0.52	0.70
4. Clay tile sewer 12 in.	12,796 ft.	0.75	0.66	0.88
5. Conc. tile sewer 10 in.	6,739 ft.	0.60	0.49	0.71
6. Conc. tile sewer 12 in.	12,796 ft.	0.80	0.63	0.90
7. Trenching, 0–5 ft.	11,860 ft.	0.28	0.60	0.30
8. Trenching, 5–7 ft.	2,740 ft.	0.40	0.60	0.33
9. Trenching, 7–9 ft.	4,145 ft.	0.60	0.60	0.39
10. Trenching, 9–11 ft.	700 ft.	1.10	1.00	0.49
11. Trenching, 11–13 ft.	100 ft.	2.00	1.50	0.82
12. Manholes, complete	11 ea.	65.00	80.00	70.00
13. Extra depth	1 ft.	8.00	10.00	9.00
14. Conc. creek cross'gs	120 c. y.	20.00	18.00	17.00
15. Earth fill	525 c. y.	0.50	0.50	0.50

LOW BIDDERS (SCHEDULE B):

1. Ellerman-McLain, Yankton, S. D..... $42,537
2. H. H. Hackett, Rapid City, S. D. (contract).. 46,045
3. Bonesteel & Hyde, Watertown, S. D..... 47,945

SCHEDULE "B"

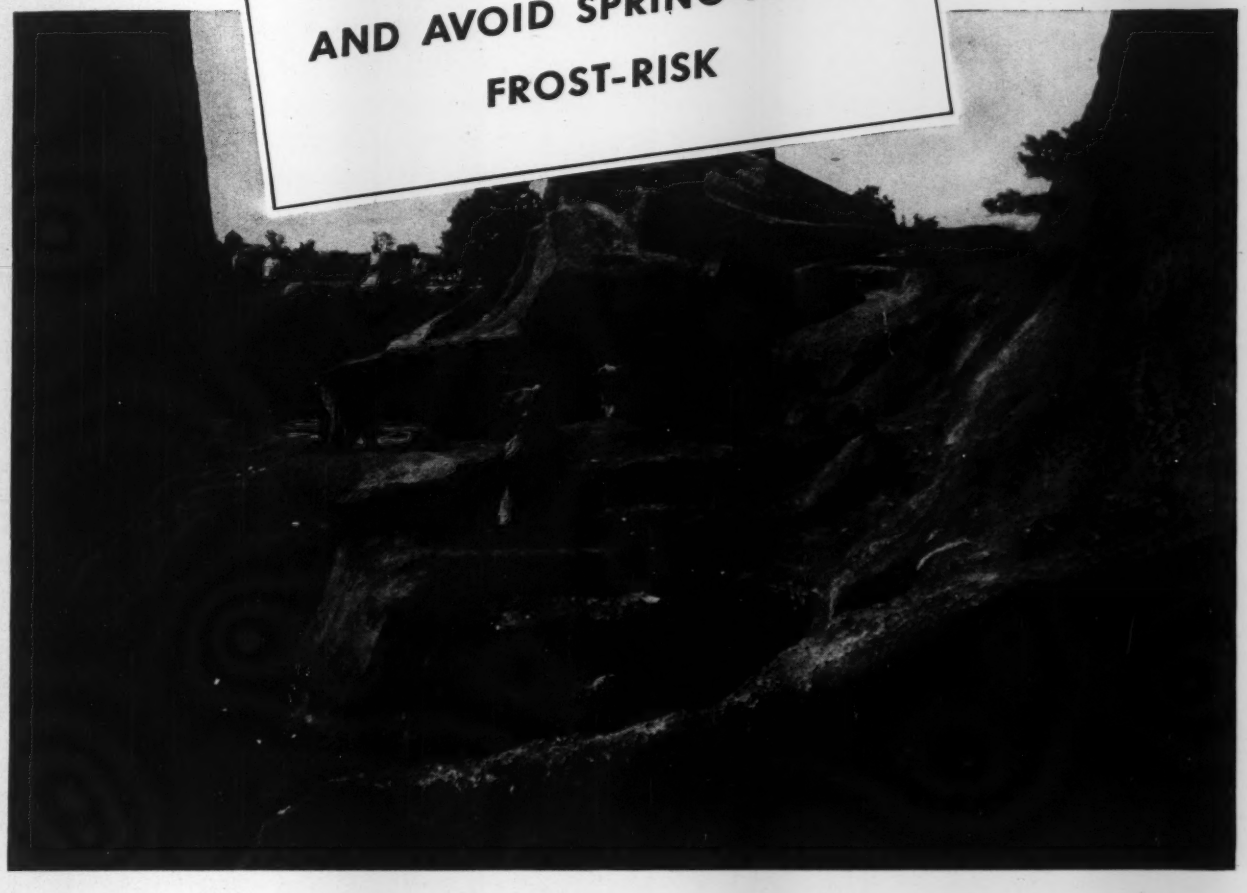
16. Wet excav.	10 c. y.	2.00	3.00	3.00
17. Rock excav.	10 c. y.	3.00	4.00	3.00
18. By-pass, M.H. & out't.	L. S.	375.00	2,960.00	2,395.00
19. Pump & boiler house	L. S.	7,858.90	7,970.65	10,993.00
20. Primary tank	L. S.	6,200.00	4,773.71	4,235.00
21. Digester	L. S.	8,100.00	10,967.98	11,285.00
22. Filter bed	L. S.	11,500.00	10,753.35	11,141.00
23. Secondary tank	L. S.	4,000.00	4,450.23	4,230.00
24. Sludge beds	L. S.	2,343.00	1,922.38	1,806.00
25. Well, tank, mains	L. S.	1,540.00	1,602.75	1,385.00
26. Alternate above	L. S.	.....	1,671.78	1,385.00
27. Roadway & walks	L. S.	171.00	197.73	340.00
28. Laboratory apparatus	L. S.	350.00	375.83	75.00

(Contract Unit Prices continued on second following page)

(459)

BEAR THIS IN MIND

AND AVOID SPRING-NIGHT FROST-RISK



EARLY Spring is a time of serious frost hazard. Nights turn cold, even when days are balmy; unprotected concrete is often exposed to freezing damage. Play safe—use 'Incor' 24-Hour Cement.

'Incor' hardens 5 times as fast, is safe from freezing that much sooner. Just heat mixing water, promptly protect the placed concrete, and your worries are over. For 24-hour service strengths, use 'Incor' and supply adequate heat overnight.

Take a tip from Robert G. Regan Co., general contractors for the new Kodiak Bear Den at Chicago Brookfield Zoo—Edwin H. Clark & Herbert Banse, Inc., architects; Carl A. Metz, structural engineer. They used 'Incor' and (1) cut heat-protection cost in half; (2) re-used forms every 48 hours, substantially reducing form costs; while (3) faster completion cut time or overhead costs to the bone. Strong, dense, watertight concrete was obtained, under difficult job conditions.

Figure these advantages on work in progress this Spring. Switch to 'Incor'* and save time, money and trouble. Write for copy of "Cold Weather Concreting." Lone Star Cement Corporation, Room 2284, 342 Madison Avenue, New York. *Reg. U. S. Pat. Off.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT

Sales Offices: ALBANY, BIRMINGHAM, BOSTON, CHICAGO, DALLAS, HOUSTON, INDIANAPOLIS, JACKSON, MISS.; KANSAS CITY, NEW ORLEANS, NEW YORK, NORFOLK, PHILADELPHIA, ST. LOUIS, WASHINGTON, D. C.

(Contract Unit Prices continued from page 76)

DREDGING, WISCONSIN

OWNER: U. S. Engineer Office, Milwaukee; Lt. Col. W. H. Holcombe in charge.

PROJECT: Dredging 243,000 cu.yd. of material from channel in river at Manitowoc Harbor. 10,000 cu.yd. of material is to be removed the first month and removal is to proceed at the rate of 40,000 cu.yd. per month thereafter. Material is removed by dipper dredge and placed on scows which are dumped in deep water.

BIDS: Five bids were received February 17, 1939, ranging from $99,630 to $150,660. Stipulated wages are as follows: Skilled, $1.11 per hr.; common, 90c. per hr.

LOW BIDDERS:*

1. Great Lakes Dredge and Dock Co., Milwaukee $99,630
2. Roew Steamship Co., Sturgeon Bay, Wis..... 108,135
3. Fitz Simmons & Connell Dredge & Dock Co., Chicago 131,200

* Engineers Estimate, $77,270.

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dredging	243,000 c.y.	$0.41	$0.445	$0.54

DELAWARE AQUEDUCT, NEW YORK

OWNER: Board of Water Supply of the City of New York; George J. Gillespie, president.

PROJECT: Contract 318, construction of a portion of the Roundout-West Branch tunnel of the Delaware aqueduct in the town of Marlboro, Ulster County, Newburgh, Orange County, and Wappinger and Fishkill, Dutchess County, N. Y. Time for completion of this contract is 72 months. Tunnel cross section is to have a 13½-ft. finished diameter. In placing concrete lining in the tunnel, special care is to be taken to force the concrete into all the unevennesses of the rock. Concrete for the lining in the upper portion of the tunnel is to be placed by pneumatic or mechanical methods through pipes which discharge as nearly as practicable in the highest part of the excavation. Minimum labor rates are as follows: skilled, $1.20 per hr.; semi-skilled, 75¢ per hr.; common, 65¢ per hr.

BIDS: Seven bids were received Mar. 2, 1939, ranging from $10,679,710 to $12,659,990.

LOW BIDDERS:

1. Pleasantville Constructors, Inc., Pleasantville, N. Y. $10,679,710
2. Shasta Construction Co., Croton Falls, N. Y. 11,161,570
3. Mason & Hanger Co., Inc., New York, N. Y. 11,362,000

UNIT NO. 3

Contract time, 365 days; total high bid of four, $493,465.

LOW BIDDERS:

1. Puget Construction Co., Clarkston, Wash. (contract) $447,224
2. General Const. Co. & Columbia Const. Co., Seattle 460,470
3. Puget Sound Bridge & Dredging Co. & Parker-Schram Co., Seattle 479,187

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Land borings	2,000 l.f	$5.00	$5.00	$6.00
2. River borings	1,500 l.f.	10.00	12.00	12.00
3. Excav of shafts tunnel and drifts	375,000 c.y.	10.80	11.25	13.75
4. Enlarg. of shafts, tunnel and drifts	6,000 c.y.	11.80	12.60	10.00
5. Protect. coatings of cement mortar	550 c.y	20.00	16.50	30.00
6 Struct. steel support in shafts, tunnel and drafts.	8,500,000 lb.	.05	.07	.055
7. Timbering in shafts, tunnel and drifts	1,700 M.b.m.	80.00	120.00	80.00
8. Dry packing	8,000 c.y.	7.50	8.00	5.00
9. Pumping from shafts, tunnel and drifts	1,500,000 mil. ft. gal.	.07	.11	.12
10. Drainage channels for shafts, tunnel and shafts.	37,100 l.f. shs. tun. and drift	27.00	19.00	25.00
11. Cutting channel for water-stop	500 s.f.	8.00	7.50	5.00
12. Steel interlining in shaft 6 and drifts	2,365,000 lb.	.10	.10	.09
13 Steel interlining in risers.	540,000 lb.	.10	.08	.10
14. Forms for masonry linings of shaft 6 and drifts	950 l.f. shs. tun. and drift	65.00	50.00	30.00
15. Forms for lining of steel risers	1,600 l.f. risers	10.00	21.00	8.00
16. Forms for ladder-way and air-duct in shaft 6	1,300 l.f. lad. and airduct	10.00	20.00	5.00
17. Forms for masonry lining of tunnel	38,000 l.f. tunnel	16.00	14.50	10.00
18. Conc. masonry in shafts, tunnel and drifts	184,000 c.y.	7.50	8.60	7.00
19. Excess conc. masonry	30,000 c.y.	5.00	5.00	5.00
20. Bit. curing solution for conc. masonry	30,000 s.y	.08	.12	.10
21. Drilling holes in rock or masonry	58,000 l.f.	1.00	.55	.50
22. Steel pipes for grouting	37,000 l.f.	1.00	.70	1.00
23. Making connections for grouting	12,000 ea.	4.00	3.50	4.00
24. Sand for filters, grout and protective coatings of cement mortar	6,000 c.y.	3.50	3.80	4.00
25. Mixing and placing grout	18,500 c.y.	8.50	15.00	12.00
26. Removal of soil	500 c.y.	1.50	.80	2.00
27. Earth excav	19,000 c.y.	1.00	.70	.80
28. Rock excav. in open cut	1,100 c.y.	10.00	6.00	8.00
29. Refilling and embanking	40,000 c.y.	.60	.70	.80
30. Surface dressing and grassing	16,500 c.y.	1.50	1.70	2.00
31. Timber in open cut	60 M.b.m.	100.00	120.00	10 .00
32. Conc. masonry in open cut	5,750 c.y.	12.00	19.00	12.00
33. Granolithic finish	1,700 s.y.	1.50	1.50	1.50
34. Granite trim	220 c.y.	185.00	180.00	210.00
35. Brick facing masonry	160 c.y.	85.00	60.00	80.00
36. Brick backing masonry	850 c.y.	40.00	36.00	30.00
37. Conc. roof titles	1,100 s.y.	12.00	12.00	14.00
38. Vit. pipes and conduits	1,700 l.f.	1.50	1.20	1.50
39. Dry rubble masonry and paving	150 c.y.	20.00	12.00	12.00
40. Rubble masonry and paving in mortar	50 c.y.	25.00	14.00	15.00
41. Cru. stone and gravel	60 c.y.	6.00	5.00	4.00
42. Conc. pav	230 c.y.	10.00	11.00	12.00
43. Portland cement	525,000 bbl.	2.20	2.20	2.15
44. Reinf	1,825,000 lb.	.05	.063	.05
45. Struct. steel	1,000,000 lb.	.05	.07	.06
46. Steel sheet piling	250,000 lb.	.04	.055	.04
47. Gratings, ladders, stairs, covers and frames	75,000 lb.	.18	.15	.20
48. Cast-iron pipes and fittings.	65,000 lb.	.12	.10	.08
49. Misc. cast iron, wrought iron and steel	210,000 lb.	.11	.14	.15
50. Galv	220,000 lb.	.04	.04	.03
51. Misc. bronze, brass, copper and lead	155,000 lb.	.60	.70	.50
52. Articles of aluminum	25,000 lb.	1.20	1.25	1.20
53. Installing and testing equipment and metal-work furnished by the city	1,400,000 lb.	.05	.045	.04
54. Painting	225,000 s.f.	.05	.05	.03
55. Liquid chlorine	10,000 lb.	.08	.10	.10
56. Sanitary services	L.S.	100,800.00	79,200.00	50,000.00
57. Restoration of grounds and cleaning up	L.S.	5,000.00	20,000.00	5,000.00

BUILDING, APRON AND SLIPWAY, BRITISH COLUMBIA

PROJECT: Construction of and alterations to buildings, and the construction of an apron and slipway at the Royal Canadian Air Force Station, Alford Bay, B. C., to be finished by June 15, 1939. Contract was awarded to the Northern Construction Co., J. W. Stewart, Ltd., and E. J. Ryan Contr. Co. Ltd., Vancouver, on their bid of $119,000. There were two other bidders. Unit Prices are as follows: Buildings, 2,000-lb. concrete, $25.00 per cu. yd.; Apron and slipway, earth excav., 80c. per cu. yd.; rock excav., $3.00 per cu. yd.; stone fill, $4.25 per cu. yd.; riprap in place, $5.00 per cu. yd.; conc. $3.00 per cu yd.; Wakefield sheet piling $1.00 per sq. ft.